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9. ABSTRACT This assessment of the agricultural potential of the Central Tunisia Rural Development Project Area relies on documents and on-site visits. Since the majority of the area's residents are dryland farmers with small farms, the team devoted the major share of its time and resources to proposals which would be directed at this group. The objective was to improve the income level of dryland farmers in the region which currently stands at only ten to twenty% of the Tunisian national average. A number of constraints to production are identified, these include physical factors, technological limitations, human resource constraints, economic constraints, sociocultural constraints, and institutional factors. The proposed program seeks to provide water for irrigation to as many of the dryland famers as possible; and it offers proposals for maximizing the income of dryland farmers who must remain in a dryland condition. Interventions for USAID funding are proposed under three general headings: facilities-equipment, demonstrations, and adaptive research and training. A project should include a systematic evaluation component. An evaluation research effort can provide a mechanism for making modifications in program plans and for eliminating components of programs that are ineffective. The report expresses guarded optimism that the lives of some of the area's residents can be markedly improved as a result of the proposed interventions. Preliminary cost estimates are included for the proposed USAID interventions.

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An Assessment of the Agricultural Potential of Central Tunisia

Evaluations and Recommendations

by

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Sponsored By the
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Contract AID/Afr-c-1139

April, 1978

AN ASSESSMENT OF THE AGRICULTURAL POTENTIAL OF CENTRAL TUNISIA

Contents

PREFACE

Introduction

This assessment of the agricultural potential of the Central Tunisia Rural Development Project Area was sponsored and financed by USAID in Washington and the Tunisia AID Mission under Contract No. AID/Afr-C-1139, Work Order No. 5. The assignment was completed from Feb. 22 through April, 1978.

Four staff members from the University of Missouri, Columbia, collaborated in all phases of the evaluation assignment. They represented four different disciplines as follows: Charles F. Cromwell, Jr., Agricultural Engineering; Albert R. Hagan, Agricultural Economics; Earl M. Kroth, Agronomy; and Michael F. Nolan, Rural Sociology.

Work procedures included conferences with USAID staff members in Washington and five week's time in Tunisia as explained on pages 12-15 of this report. Further evaluation of data and report preparation were completed during April in Columbia.

Acknowledgments

Members of the team wish to acknowledge with appreciation the wholehearted cooperation of USAID and GOT staff members in all phases of the study. Special gratitude is extended to several individuals who worked most closely with the team in Tunisia, as acknowledged on pages 13 and 14 of this report.

List of Abbreviations

A large number of different institutions and agencies serve a variety of roles in agricultural development programs in Tunisia. For convenience in referencing, abbreviations are used in several sections of the report, in accordance with the following list.

1. USAID -- United States Agency for International Development
2. IBRD -- International Bank for Reconstruction and Development (World Bank)
3. FAO -- Food and Agriculture Organization of the United Nations
4. GOT -- Government of Tunisia
5. UNAT -- National Farmers Union of Tunisia
6. CRDA -- Regional Commission for Agricultural Development
7. CNEA -- National Center of Agricultural Studies
8. INRAT -- National Institute of Agronomic Research
9. INRFT -- National Institute of Forestry Research
10. DRES -- Water and Soil Resources Office
11. BIRH -- Hydraulic Resources Inventory Bureau
12. CES -- Soils and Water Conservation
13. DAFL -- Land Tenure and Legislation Office
14. BPDA -- Planning and Development Office
15. OC -- Office of Cereals
16. OEP -- Office of Livestock & Pastures
17. DPA -- Division of Agricultural Production
18. COCEMO-- Central Cooperative of Mechanized Farming
19. CCSPS -- Central Cooperative for Seeds & Selected Plants
20. BNT -- National Bank of Tunisia
21. BNA -- National Agricultural Bank
22. CLCM -- Local Mutual Credit Fund
23. FOSDA -- Special Funds for Agricultural Development
24. SCM -- Mutual Guarantee Society
25. OTD -- State Farms Office
26. SONAM -- National Society of Mechanized Farming

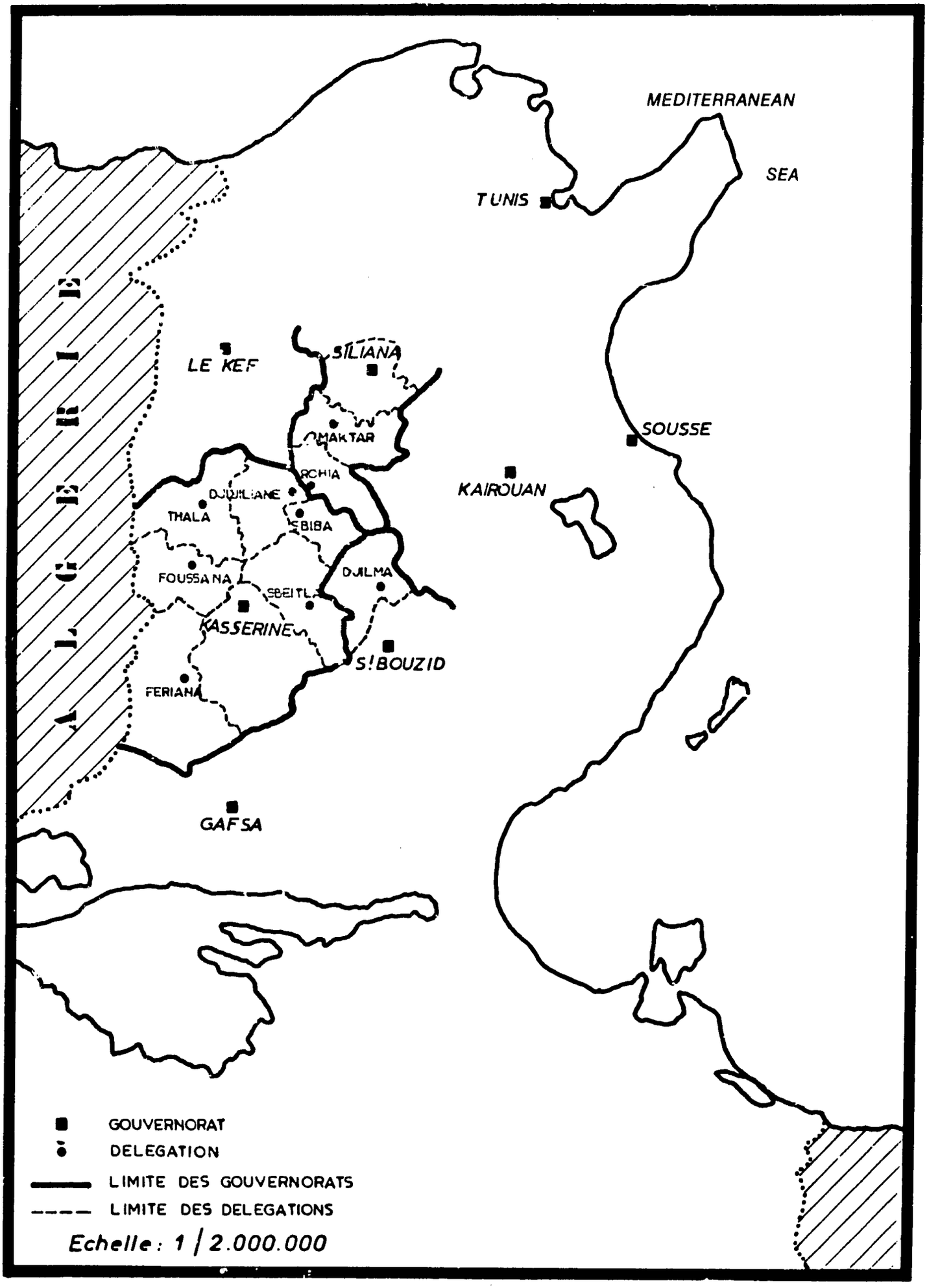

Fig. 1 Location of the Central Tunisia Rural Development Project Area

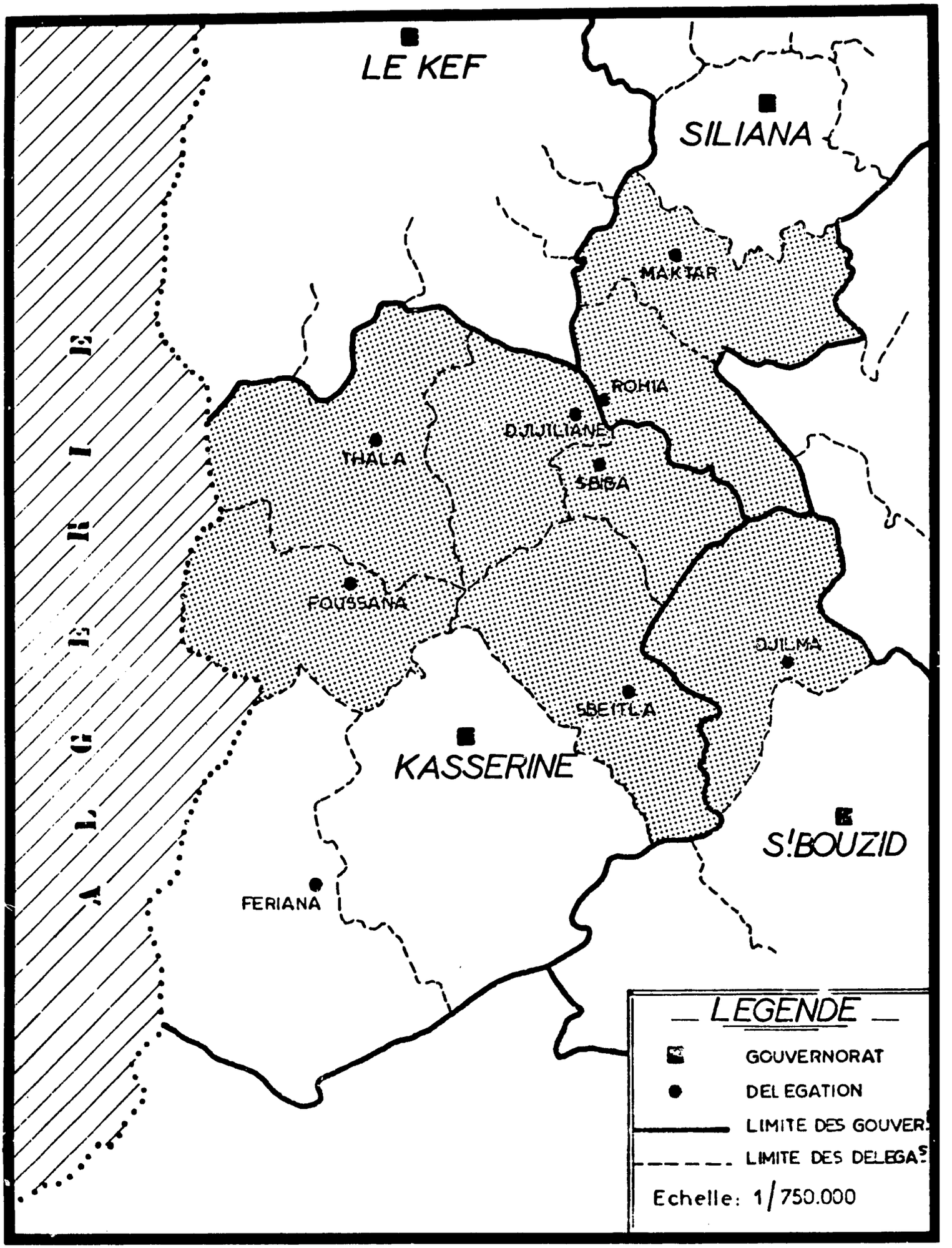

Fig. 2 Enlarged Map of the Rural Development Project Area Consisting of Eight Delegations in Central Tunisia

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The assignment of the team was to assess the agricultural potential of the eight delegations comprising the Central Tunisia project zone. Since the vast majority of the area's residents are small, dryland farmers, the team devoted the major share of its time and resources to proposals which would be directed at this group. The one overriding objective guiding the team's efforts was to improve the income level of dryland farmers in the region which currently stands at only ten to twenty percent of the Tunisian national average.

In collecting information necessary for this assessment, the team relied on documents and on-site visits. A great deal of information on the area (or portions thereof) had been collected and the team spent considerable time reviewing these materials.

The site visits and review of previously reports allowed the identification of a number of constraints to production. These included physical factors, technological limitations, human resource constraints, economic constraints, socio-cultural constraints, and institutional factors. A two-pronged strategy was adopted for recommending interventions directed at small dryland farmers. One portion of the proposed program seeks to provide water for irrigation to as many of the dryland farmers as possible. The second offers proposals for maximizing the income of dryland farmers who, by necessity or choice, must remain in a dryland condition.

The team proposed a number of interventions for USAID to consider for funding. The specific programs proposed can be organized under three general headings: facilities-equipment, demonstrations and adaptive research and training. The specific proposals follows:

Facilities-Equipment

High Priority

1. Exploit all known ground water resources in the project area. These would include, but would not be limited to, such things as pump sets, well improvement programs, equipping drilled wells with pumps, preparing land to make most effective use of irrigation water, and developing known springs.
2. Equip existing facilities at Le Kef and Ousseltia for soil fertility and plant breeding, and other related research activities.
3. Provide funds to dryland farmers to help them purchase almond trees, apiculture equipment, inputs for greater cereal productivity, etc. to help motivate and encourage adoption of recommended interventions.

Very Low Priority

1. Construct larger scale rainfall impoundment projects. At least one site for a project such as this can be identified in each delegation.

Demonstration Projects

High Priority

1. Development of a number of dispersed method-and-result demonstration projects throughout the region (perhaps in every sector) showing alternative farming systems; how to make effective use of irrigation water; how to control erosion and store rainfall on sloping land; rotational grazing--pasture improvement; new barley varieties; and potential of apiculture and arborculture.

Adaptive Research and Training

High Priority

1. Provide grant funds for wide-spread field testing and seed distribution of improved varieties of barley better adapted to dryland conditions.
2. Provide grant funds to develop range improvement strategies appropriate for Central Tunisia.
3. Provide funds to train Tunisians in U.S. universities in the fields of agronomy (soil fertility analysis, range management, and crop production), agricultural economics (farm management analysis) rural sociology (sociology of agriculture and evaluation research) and agricultural engineering (soil and water conservation and use).
4. Provide funds for short-term or long-term TDY assistance in such areas as erosion controls,

apiculture, and other specialities necessary to expedite the programs above.

INTRODUCTION

A Brief History of Tunisia

The smallest of the three countries that comprise the "Maghreb" of North Africa, Tunisia occupies an area of 163,610 square kilometers and is situated geographically between Algeria and Libya. Like most countries in the region, it has been a convenient and strategic way point for numerous invading armies during the course of its history. At one time or another it has been occupied by the Phoenicians, Romans, Arabs, Turks and most recently the French. It is worth noting that during the Roman period much of Tunisia served as a major source of food stuffs for the Roman empire. Indeed in Central Tunisia, the focal point of this study, a number of Roman ruins dictates the area was an important source of grain two thousand years ago.

In terms of climate and physical characteristics, Tunisia can be classified into three zones. The Northern region and the Coastal area as far as the Libyan border contain the largest cities and also the nation's best agricultural land, although rainfall varies considerably along this maritime belt (up to 900mm in the NE).

A second region which extends East and South of Gabes is basically a sub-saharan area. Where human habitation is

possible, it is usually quite dense and extractive industries (oil and phosphates) are relatively common. Rainfall is considerably less than along the coast.

The interior portion of the country lying between the Northern relatively wet areas and the Southern near-desert areas is distinguished by several mountain chains and a rainfall pattern of 250-350mm annually. However, considerable variation prevails in the region both with regard to rainfall and the quality of the soil in the valleys between the mountains. This area is sometimes called the High Tell with numerous mountains, valleys and upland plateaus. No major rivers flow in the area although a few smaller streams do have a year-round flow.

Modern Tunisia is considered by many to be one of the most liberal of Moslem countries. In 1974, the population was 5,641,000 with a density of 34.5 persons per square kilometer. Most of the people live in the Northern and Coastal regions of the country and 15-20 percent live in the immediate vacinity of Tunis. Near the site of ancient Carthage, Tunis combines the functions of capital city and chief port.

Tunisia as an independent state is relatively young. The French protectorate finally ended, after years of struggle, on March 20, 1956 and shortly afterwards Habib Bourguiba and his Neo-Destour Party were elected into power. Bourguiba served initially as Prime Minister but

was subsequently elected President-for-life, a position he continues to hold. Some major governmental changes have occurred during the last twenty years, the most recent being the appointment of Hedi Nouira as Prime Minister in 1970.

Administratively, Tunisia is divided into eighteen governorates, the governors of which are appointed by the President. Each governorate is divided into seven to twelve delegations, which, in turn, are subdivided into a number of sectors. The principal political party, Destourian Socialist Party (PDS), has a similar parallel structure.

Any discussion of the governmental structure as it affects agriculture is necessarily complicated in that a number of ministries and other semi-autonomous governmental units have some role in agricultural policy. Agriculture has always been a major focal point of Tunisian domestic politics which, in large measure, accounts for this. Besides the Ministry of Agriculture, the Ministry of Plan, the Ministry of National Economy, and several others have important roles in the formulation of policy -- the former in terms of capital investment and the latter in terms of pricing. The Ministry of Agriculture does maintain technical offices both at the regional level and in almost all governorates. The staff in these offices, while administratively responsible to the Ministry, have their performances evaluated by the Governor.

Tunisia has an elaborate agricultural credit structure. It originates in the National Bank of Tunisia (BNT) but several specific programs of credit are provided for farmers. The National Agricultural Bank (BNA) is the primary lending institution serving agriculture. Of particular interest are the Local Mutual Credit Funds (CLCM) which were set up specifically to help small farmers obtain credit, although there is considerable doubt as to the effectiveness of this program.

Agriculture is the focal point of the Tunisian economy and a major earner of foreign exchange. The country produces a number of commodities ranging from citrus fruits to cereals, but the principal export is olive oil. Ironically, although Tunisia is an exporter of limited quantities of durum wheat suitable for pasta, it is a net cereal importer. Likewise, red meat production, alhtough increasing, is still not sufficient to satisfy domestic demand.

The Northern areas of Tunisia have a livestock population with a relatively high proportion of cattle, while sheep and goats tend to predominate in the Central and Southern regions. Likewise, the North has developed major irrigation perimeters, particularly in the Medjerda Valley, while the rest of the country tends to rely on dryland farming.

Marketing of agricultural products is a mixture of socialism and private enterprise. Certain crops, such as

cereals, are marketed through a national marketing organization while others are simply placed on the local market or bought by wholesale dealers directly.

Tunisia's transportation system is quite viable. While only limited air service is available outside Tunis, a good network of paved roads link the major population centers. However, the secondary roads are often less than desirable, particularly during tne rainy fall and winter months.

The Central Tunisia Project Area: An Overview

The area proposed for the overall rural development project, of which this assessment is a part, is composed of eight delegations located in three governorates. Within the governorate of Kasserine, the five northern delegations of Foussana, Thala, Jedliane, Sbiba and Sbeitla have been included. The Siliana Governorate is represented by the Rohia and Maktar Delegations. The last delegation is Djilma which is located in the Sidi Bou-zid Governorate. (See Figs. 1 & 2 for maps showing the location of the project area.) Within the eight delegations there are a total of seventy-eight sectors.

One of the difficulties in describing the area is its marked heterogeneity in terms of topography, climate and available land and water resources. On the southern border of the project zone is Dejebel Chambi, which at 1544 meters is the tallest mountain in Tunisia. Much of the valley areas

lie at elevations between 500-700 meters but plateaus above 800 meters are not uncommon. Likewise the annual rainfall varies from 400mm in the North to as low as 250mm on the southern edge of the project zone. More specific rainfall data for the area are shown in Table 1. Temperatures are equally variable. Many areas experience summer highs in the 90-95^{o} F range and winter lows between 25-30^{o} F. Frosts as late as March and April are not uncommon in the high plateau areas. Two other weather phenomena are also worth noting, hail and strong desert winds. Some parts of the area report severe hail storms as often as five years out of ten and the same is true for the strong desert winds originating in the Sahara. All three weather phenomena -- rainfall, hail, and strong winds -- can be extremely variable, not only from place-to-place within the region, but also within the same locality from year-to-year. Although most of the area can be labeled semi-arid, the only truly accurate predictive statement one can make about the weather is that it's unpredictable.

Soil resources are similarly maldistributed. Some of the valleys have high quality, well drained loam-silt soils, while others range from sandy to clay types. Similar differences are found in the plateau areas as well. Most of the sloping areas are best characterized as rocky and depleted. Erosion is a major problem here, both of the sheet and the gully type. This problem will continue to worsen if more of the marginal hillside land is brought under cereal cultivation.

Table 1. Rainfall Data for the Central Tunisia Project Area.

Stations	Average Rainfall (mm)	Fall Rainfall (mm)	Spring Rainfall (mm)	Amount of Rainfall Received At Least 9 Yrs. Out of 10
Kasserine Chambi	350	100	80	200
Foussana	300	110	120	200
Thala	400	120	140	300
Sbiba	350	98	100	200
Rohia	350	100	100	200
Sbeitla	310	100	90	180
Djilma	268	85	90	180

Source: CNEA, Tunisia

The situation with regard to water resources is similar to that with soil. The irrigated perimeters in the region (principally those at Sbiba and Sbeitla) use over half the irrigation water resources in use but occupy less than one percent of the usable agricultural land. Outside the perimeters, the availability of water is far from uniform. For example, northeast of Jedliane the ground water table is only about two meters below ground level, while in the Foussana basin it is six to eight meters. In other areas ground water is not available and families often are forced to go ten kilometers for water during the summer months. Some deep wells are available in the region (up to 700 meters) but they are relatively few and their overall impact is not great.

Cropping patterns in the area assume a dichotomous form depending on whether or not one has access to irrigation water. Dryland farmers follow the traditional grain (wheat or barley) fallow rotation and graze animals (usually sheep or goats) on the fallow portion. Forage is extremely limited in the dryland areas and cactus planting has been established in many places to provide emergency forage. Throughout the region the problem of overgrazing on range lands cannot be overstated.

Some arborculture is found in the dryland areas, particularly olives, almonds and pistachios. One other dryland crop deserves mention. It is a grass that is

indigenous to the region and is known as Alfa or Esparto. Alfa grows in scattered tracts and is used locally to make rugs and similar woven products. In commercial quantities, it is used to make a high-grade paper and a plant in Kasserine processes it for this purpose. Undoubtedly Alfa provides an important source of cash income for some farm families but it has limited potential as a forage. Further, it has proven impossible to either propagate it or transplant it to other areas.

The irrigated areas are entirely different. The farm units tend to be quite small, two to four hectares, and a considerable range of crops is produced both winter and summer. Summer crops include fresh garden produce (e.g., tomatoes, peppers, cucumbers, and melons), some forage (e.g., alfalfa), and fruit trees (e.g., apples, apricots, peaches, plums, and pears). Winter crops tend to be small grain, forage and the winter hardy truck crops such as carrots and onions. Relatively little livestock is found on the irrigated perimeters except for traction animals.

Transportation in the area is of variable quality. Major paved roads link Thala, Kasserine, Sbeitla, Sbiba, Rohia, Maktar, and Djilma to each other and to other points in the country, but off those roads the situation can be quite different, particularly during wet weather. Some local transport is available, but the extent and nature of it is not well documented. Observations of various markets

indicate that the donkey is still a major method of transport for people to market and purchase commodities.

The population of the area is predominantly rural. Over ninety percent of the people in the project zone live outside centers of population and they often are found in widely dispersed dwellings. True nomadism is a thing of the past but its remaining vestiges manifest themselves in the scattered households and independent spirit that seems to characterize many of the people in the area. The GOT has had a program to encourage people to live in closer proximity to one another so that services (water, electricity, education) can be provided at less cost, but it has had only limited success thus far. Families are strongly patriarchial in nature although women and children play important roles in agricultural production. Census data indicates approximately six persons per household, but this figure may be low due to an under-enumeration of females. The population is also young with approximately fifty percent of the people under fifteen years. (Appendix Table 1 contains further descriptive data of the population of the project area.)

One demographic pattern worth noting is the consistent out-migration of males. In the past, many men from the region went to Europe to find work, sending back remittances to support their families. While the European labor market has tightened, a shortage of labor in Libya has attracted a number of young men to that country. The GOT, while

officially denying the problem, is unofficially concerned and lines at post offices cashing remittance checks are common throughout the region.

The living standards in the region are quite different depending upon location. In the irrigated perimeters of Sbiba and Sbeitla, incomes approaching the Tunisian national average ($1,700) are not uncommon; and, water and electricity for household use are available. In most of the dryland areas life is much harder. The task of obtaining water for the family must occupy a great deal of time in many families, particularly for the women and children. Incomes in these areas range from ten percent to twenty percent of the Tunisian national average. While one does not see examples of abject misery, such as in Bangladesh, it is clear that many families are only barely getting by and as their land becomes more depleted, their situation will only get worse.

On the positive side, in driving through the area, one can't help but be impressed with the number of schools which are operating in spite of their extreme isolation. It is estimated that seventy to seventy-five percent of the eligible males are enrolled in primary school and twenty-five to thirty percent of the females.

Assignment for the Team

The team was assigned three specfiic objectives by AID/Washington. They were:

1. To make a systematic analysis of the agricultural potential of the proposed project area and research and technical assistance requirements for long-term development;
2. To develop alternative strategies for agricultural development of the proposed program area over the next several years and assess present GOT technical research strengths relating to semi-arid agricultural problems of central Tunisia; and
3. To indicate the relative feasibility and priority of specific agricultural development activities and assess the status of existing linkages between GOT semi-arid staff and international semi-arid agricultural research efforts.

Each of the team members were also assigned some specific questions to address relevant to his discipline and upon arrival in Tunisia, further issues were suggested for the team by John S. Blackton and James Dalton (Blackton and Dalton, 1978).

Procedures

Two methods of data collection were utilized while the team was in Tunisia. First, considerable time was devoted to reading existing documents and talking with knowledgeable persons about the area and/or Tunisian agriculture. Second, the team spent approximately three weeks visiting the eight

delegations and individual sectors in the project area in an attempt to see firsthand the constraints to production. (A summary of visits is included in the Appendix.) An elaboration of each approach follows.

The area does not want for lack of research. During the past ten to fifteen years several major studies of various types have been completed in various portions of the project area. In addition, data on resources, both water and soil, are fairly well known, at least for portions of the region. Much of this work has been done by the Tunisians themselves, but outside agencies have also played a major role, notably FAO. The team was provided with all the documentation it requested and for those documents not available in English, translation services were provided. Included in the bibliography are references to those documents which were examined. In addition to reading, interviews were conducted with officials in the Tunisian Ministry of Planning and Ministry of Agriculture to obtain their views on the problems and potentials of the area. The Minister of Agriculture provided contract services to USAID/Tunisia which permited the team to utilize the resources at the National Center for Agricultural Studies (CNEA). Two staff members there, Ms. Monia Bouratbine (Agricultural Economist) and Mr. Mohamed Ech-Chebeane (Agronomist) were particularly helpful. The entire team was impressed with the level of competence and research skills of the CNEA staff.

The staff at USAID/Tunisia was also very helpful. The advice obtained from Dr. Carl Ferguson (Food and Agriculture) and Dr. Patrick Demongeot (Rural Development) was particulary useful. In addition, conferences with the livestock project team members (USDA/PASA) proved very beneficial in directing certain aspects of the fieldwork.

Finally, special recognition should go to the three USAID/Tunisia staff members who accompanied the team in the field. Without the language and analytical skills provided by Salah Mahjoub, Tahar Ben-Salem and Richard Fraenkel (TDY), the fieldwork phase of the project would have been nearly impossible. The team benefited greatly from the frequent exchanges of ideas, insights and interpretations it had with these three individuals. Their contribution to this report cannot be overstated. In addition, Ms. Joyce Jett (IDI) accompanied the team during a portion of the fieldwork and was of considerable assistance both in the field and in Tunis.

The time spent in actual field work consisted of two distinct blocks. During the first phase the team met with several officials at both the governorate and delegation levels and toured seven of the eight delegations in the area, usually accompanied by local representatives of the Ministry of Agriculture (CRDA). During this overview, about two dozens interviews with farmers were taken. Although they tended to be of the unstructured variety, the interviews provided some very useful information.

The second phase involved visiting the eighth delegation (Djilma) and making return visits to those areas where additional information was needed. Also revisited were those areas which showed particular promise for certain development efforts.

While the time spent in the field was not sufficient to totally understand all the subleties of agricultural production in the region (to do that would probably require years), it was felt that a reasonably accurate assessment of the constraints to production and the potential for more effective resource use was made and that additional time spent at this point would have been counterproductive.

During the fieldwork phase, the team received excellent cooperation from local government officials and the CRDA. When it was available, all data requested were supplied in rapid fashion.

Appendix A outlines the general strategy followed in determining the resources of the region and the likely impact of proposed interventions.

GOALS FOR THE DEVELOPMENT OF THE AGRICULTURAL SECTOR OF CENTRAL TUNISIA

The overriding goal of the team throughout the period of the assignment was to devise strategies and techniques to improve the quality of life of the small cultivators in the project area. They comprise at the same time the largest single grouping of farmers (e.g., in the Sbiba Delegation, eighty percent of the farmers are on units of five hectares or less) and also those in the worst financial condition. The objective was to improve not only their cash position, but also their nutritional level and other more subjective indicators of an improved state of well being. Throughout it was the team's intention to work to the greatest extent possible within the existing resources and level of technology present in the area and to minimize disruptive impacts on the social structure of the area. Great care was taken to determine what the people desired rather than simply imposing a given set of changes upon them.

Four specific goals structured most of the field observations and the ensuing recommendations. They were:

1. To make more effective use of known land and water resources already available both in the dryland and irrigated areas;
2. Examine carefully the livestock grazing patterns

with the intent of establishing pilot projects using new strategies to control overgrazing;

3. To examine the research resources relevant to the area particularly with regard to the adaptive research strengths in Tunisia could be used to quickly identify and develop crops, forages, and other interventions suitable for the Central Tunisian region; and
4. To devise strategies to encourage qualified Tunisian technical specialists to live and work in Central Tunisia.

CONSTRAINTS TO AGRICULTURAL PRODUCTION IN CENTRAL TUNISIA

During the course of reviewing the available documentation relevant to the area and spending time in the field, numerous constraints to agricultural production in Central Tunisia were identified. For the purpose of simplifying discussion, these have been grouped into six categories although it should be noted that the boundaries between categories are not well documented. The six categories are (1) physical constraints, (2) technological constraints, (3) human resource constraints, (4) economic constraints, (5) socio-cultural constraints, (6) institutional constraints.

Physical Constraints

It goes without saying that the physical obstacles to increased production are formidable. It was noted in an earlier section that rainfall is not only limited (250-400mm), but also occurs only during a limited period of the year and is highly variable over time and from place-to-place. All this makes rainfall storage projects very risky ventures. Besides rainfall, the other weather phenomena common to the area (hail, strong winds, and wide summer-winter temperature extremes) have to be kept in mind when planning specific interventions.

The soil in the area is of variable quality. Some is quite good, but substantial areas have rocky, poorly-drained soils and others have noticeable salt build-up. Erosion is common throughout much of the region and while the Tunisians have made some efforts to slow the worst of the gully type, sheet erosion is largely unchecked. This is aggravated by a vertical system of plowing often mandated by the small ownership tracts common to the region. Although specific data were lacking, widespread variations in soil fertility seemed to exist throughout the area.

The same kind of differences also are true for water resources. Ground water is found at varying depths in many locations throughout the region but by no means everywhere. Some salinity problems impose limitations in land use but they are relatively isolated. Of considerable concern to the team was the need for many families to go considerable distances in order to obtain water for human and animal needs. The expenditure of human labor in this task must be enormous.

A final physical constraint observed concerns the disappearance of nearly all the native perennial grasses on overgrazed rangelands. Livestock on those lands must now depend on weeds and annual grasses for survival.

Technological Constraints

A number of situations were observed where the existing resources, especially water, were not being effectively used

because of the lack of a technology appropriate to the task. There were a number of examples of ineffective utilization of water on irrigated plots through a failure to properly grade the level land. In addition, some areas which had wells suitable for small-scale irrigation lacked pump sets. Compounding these problems was an apparent lack of a well organized maintenance structure for those pump sets that were in use. Finally, those water management structures observed (e.g., terraces or small storage basins) were often ineffective due to poor design and/or silting.

The team also observed that little knowledge about the proper application of fertilizer has reached the dryland farmers. Some farmers apply it, but in a manner which appeared to reduce its effectiveness. Others don't use it at all.

Human Resource Constraints

The team observed a number of well-trained Tunisian agricultural technicians but a point that was heard over and over again in discussions with local government officials was the extreme difficulty they experienced in recruiting these specialists to serve in rural areas. Most simply don't want to work outside Tunis or the other coastal cities for reasons of social amenities and because they perceive such an assignment to be damaging to their careers. Obviously this is a major problem.

On the farm level there is a definite oversupply of labor. It is safe to say that in most parts of Central Tunisia there are simply more people than the land will support. The dual problems of unemployment and under-employment abound. This has resulted in a substantial out-migration of young males which some feel might result in a labor shortage if the type of farm enterprise were to shift so as to require more labor (e.g., moving from dryland farming to irrigation).

Economic Constraints

The foremost problem facing most farmers in the region is lack of financial resources. This manifests itself both in current income and the lack of access to available credit structures. This is, in turn, linked to the risk situation. Most farmers are of the subsistence or near-subsistence type found in many cultures and simply aren't in position to make radical changes in their methods of operation because the cost of failure would be so high.

Another serious constraint is the lack of data for various enterprises. Before adjustments to farm enterprises can be proposed, this information is essential in order to evaluate the economic consequences of different systems.

Two other constraints of an economic nature also caused concern. The first of these is the lack of access to markets for many people due to distance, poor roads or both.

This has particular implications for the marketing of perishable products such as fruits and vegetables.

Second, pricing policies of the GOT may encourage the production of certain crops not particularly suited for the region. This is particularly true for barley-wheat. The fixed price of barley is substantially lower than wheat, but the region is better suited for barley. This constraint has been noted in other studies and reports but continues to be a major problem.

Socio-Cultural Constraints

In proposing changes in the farm enterprise system in Central Tunisia, it is important to keep in mind that one is dealing with an agricultural society which has evolved over thousands of years. Change, if and when it does occur, will come slowly and adjustment problems will have to be anticipated.

A specific cultural norm, which is particularly relevant to the problem of overgrazing is the very important place sheep and goats occupy in the existing social structure. Their very numbers are a source of prestige to individual farmers and because of their easy liquidity, they are a form of banking on the hoof. When a farmer does manage to acquire a little extra cash he will often use it to purchase another ewe, which of course only compounds the overgrazing problem. Much like the American cattlemen's love affair with beef cattle, sheep in Central Tunisia are a very important

component of the lifestyle of family units. In shifting from a dryland livestock enterprise to an irrigated operation (even if small in size), certain strains are bound to result.

A second constraint is the self-imposed isolation which characterizes many of the people in the area. This makes outreach programs all the more difficult and all the more important because opportunities to learn by observation are limited. This isolation also means the potential for cooperation among families and even within extended families is probably limited although several examples were observed of multifamily units sharing irrigation water from a central source.

Finally, the Moslem system of inheritance which sets down very specific rules on the distribution of property at the time of the owner's death has created a system of extremely fragmented land holdings, often too small to support a family. Often the land is not sold but kept as a kind of savings account in the event of emergency. The problem of land fractionalization has baffled experts in this part of the world for a long time and remains a major stumbling block for long-term agricultural development programs.

Institutional Constraints

Four major institutional constraints were observed during the period of field work. First, considerable doubt

was expressed by all the members of the team as to the effectiveness and extent of the technology transfer mechanisms, particularly those designed to reach small dryland farmers and irrigated farmers outside the major perimeters. Simply put, the limited knowledge that is available is often not getting to the people who need it most.

Second, the organizational structure of the agricultural establishment is very confusing. There appears to be both duplication of effort in some areas and nothing being done in others. For example, the relationship between CRDA and the extension service was never made clear. There seems to be a notable lack of coordination among the myriad agencies which impact in agriculture at the local level. If the situation is confusing to a team of professionals, one can't help but wonder how it must appear to a small farmer seeking help for a specific problem.

Third, the credit structure does not seem to serve the needs of small farmers adequately. Several examples of loan applications for pumps lying inactive for large periods of time were observed. This problem has been discussed elsewhere and was the prime impetus for the Small Farmer Credit Project proposed for the northern part of the country. Most of the problems noted in reports of that project apply to Central Tunisia as well.

Finally, the land title situation remains a very real problem. Some delegations, notably Foussana, have made

major strides in getting land titled, but such efforts elsewhere are uneven and seem to depend on the motivation of the local delegate. Since loans can't be approved without titles and most improvements require loans, this has profound implications for development efforts.

ALTERNATIVE DEVELOPMENT STRATEGIES

The selection of a strategy for directed change is, at the core, a value decision. Certain analytical tools such as cost/benefit analysis or input-output modeling can be brought to bear, but they tend only to add an objective patina to what is intrinsically a subjective process. Recognizing this, it is necessary to spell out the various alternatives from which one intends to choose and the value criteria upon which the eventual choices will be based. This section of the report is directed to these dual tasks.

Overall Rural Development Approaches

Blackton and Dalton's report (1978) on "Tunisie Centrale" does a good job of outlining three alternatives for approaching the problems of rural development in Central Tunisia.

First is what they label the Production First approach. In essense this calls for a major share of resources to be spent on projects which would increase the "output" from Central Tunisia, whether it is in the form of agricultural products or manufactured goods. While possibly benefiting the Tunisian economy as a whole, such an approach would do little for the vast majority of the region's residents. Summarized, the Production First strategy would do a lot for a few.

Second is what they call the Employment Generation/ Service Infrastructure approach. This strategy lies at the opposite extreme from the first. It would try to do a little for many by providing training services and/or employment for several thousand people and outreach services (conceivably either of the educational variety or more concrete kinds such as transportation services) to as many of the area's residents as possible. Obviously the outputs from such a program would largely stay in the area, but the distribution of benefits would be spread so thinly as to be immeasurable.

The final approach they offer is termed the Production/ Equity strategy. In their own words:

> This approach. . . emphasizes productivity and income generation while at the same time keeping the poorer farmers of the zone (the 88% of the target group presently in dry farming) as the primary point of focus.

They go on to outline more specific proposals which might accomplish this. Let it suffice now to say they conclude by endorsing this strategy which is in many respects a marriage of the first two approaches -- do a lot for as many of the poor as you can but try to do a little something for everybody. Within the limitations of finite resources this will require very careful planning but its intrinsic appeal overshadows these problems.

Agricultural Development Strategies

Applying the Blackton-Dalton model to agriculture is relatively simple. First, if one chooses to emphasize

production at the expense of equity considerations, major investments in the existing irrigated perimeters would be in order in spite of the fact that the farmers in those perimeters are doing well compared with their dryland counterparts.

Second, a pure equity model would call for a program which would deal exclusively with dryland farmers in an attempt to improve their lot within the constraints of the dryland condition.

Third, an integrated strategy, blending features of production and equity, would try to dramatically develop the productivity of dryland farmers by putting irrigation resources at their disposal and provide interventions for those who can't irrigate under any circumstances. The recommendations that follow later in the report embrace this approach.

Two factors played a role in the selection of the third approach. First was the tremendous importance of agriculture within the boundaries of the project area. Any discussion of rural development, however defined, in the eight delegations visited by the team has to include an agricultural component as such a high percentage (eighty to ninety percent) of all the area's residents live in such marginal dryland conditions. This is not to deny the importance of service delivery programs. Many services are lacking. However, it was the opinion of the team that before issues such as transportation systems are entertained,

one should first give the people a reason for going somewhere, something to sell or money with which to buy. Equating agricultural development with rural development, in the case of Central Tunisia, is one of the value choices mentioned earlier.

The second reason for choosing the third strategy was the early recognition there was little anyone could do to bring the income of dryland farmers anywhere near the Tunisian national average and keep them in their dryland condition. Land holdings in the area have become so fractionalized through time (many holdings are five hectare or less) that even the best designed farming system for a dryland area will be hard pressed to generate a one- or two-fold increase in income, much less the ten-fold increase which is often needed.

At the same time there is considerable evidence that the land will produce when water is applied and that a family can do reasonably well on a relatively small (two to four hectare) plot of irrigated land. It was also noted that a great amount of potentially irrigatable land now being farmed by small dryland operations could be brought under irrigation for a modest investment and thereby markedly improve the income of those affected.

The following proposals are based on this approach and these values. Essentially, the team argues for a division of resources between programs to help dryland farmers in

dryland conditions and programs designed to assist dryland farmers to become irrigated farmers. The task will not be an easy one, but if carried out it will have the greatest impact on those people who need it the most.

RECOMMENDED PROGRAMS AND INTERVENTIONS

Introduction

Since agricultural development is only one phase of the overall Central Tunisia Rural Development Project, it is assumed that the organizational and administrative structure will be a part of the comprehensive project design. No new agencies and organizations of a general nature will be proposed. However, close coordination and integration of the work of several different groups and services are considered essential for prompt and successful implementation of programs in the agricultural sector. These will be indicated in later sections of the report.

As earlier indicated, farms in the project area are predominantly small, subsistence-type units. For most, resources are restricted and both physical and economic limitations preclude any spectacular and rapid increases in the productivity, earnings, and level of living of most of the farm families in the project area. This does not mean, however, that nothing can be done to help them. On the contrary, members of the agricultural assessment team concur in the conviction that meaningful and impressive progress can be made through sound and reasonable interventions which are within the reach of their resources and

abilities. The recommended procedures for developing the agricultural sector of the rural development project are based upon this conviction.

Proposals for agricultural development throughout the remainder of this report are based upon a few fundamental premises which evolved from visits in all of the eight delegations by some or all of the team members and through numerous personal interviews with public officials and representative individual farmers. (A summary of visits in the various delegations and sectors is included in the Appendix.) These are as follows:

1. That small, private farmers in the area are independent, self-reliant, and hard-working people who are friendly, responsive, and innovative (even though many of the older ones may have had limited opportunity for formal education);
2. That these same farmers are conservative, security-minded, and survival-conscious and that these characteristics must be kept in mind in proposals for adjustments;
3. That the farmers also are rational economic entrepreneurs who are receptive to adopting new technologies and improved farming systems, <u>if</u> they they are convinced that such changes lead to higher income, better living, and security for their families;

4. That the most convincing and powerful motivation for such interventions is the successful application of them on individual, neighboring farms with similar resources and problems; and finally,
5. That the Government of Tunisia is fully committed to allocating the resources need for comprehensive development of agriculture in the eight delegations of the Central Project area.

To insure that the reader understands the thrust of the recommendations, the next section offers a brief explanation of the terminology and concepts employed in the remainder of the report.

Pilot Demonstration Areas

Pilot demonstration areas provide nuclei from and around which the application of numerous interventions can be illustrated in a coordinated and integrated manner. They serve as "show windows" for various proven technologies which are adapted to the resources and conditions of the area.

For successful implementation, several guidelines are suggested. These include: site selection, local involvement of all farm families and their leaders in the area, close supervision and coordination during the planning and the development stages, a systematic procedure for gathering data for evaluation of progress as a basis for future adjustments expansion, and making full use of the demonstration areas to encourage the adoption of proven interventions throughout the delegations and sectors.

Method and Result Demonstrations

Method demonstrations to show how to apply new technologies and result demonstrations to illustrate the consequences of their use have been used successfully for many years in educational programs with farmers. The latter can be an integral part of application-type research in the project area.

Many types of demonstrations which are well done and successful have proven useful in motivating widespread adoption of the interventions illustrated. Unfortunately, those which are poorly executed and never completed may have an even stronger adverse influence. This emphasizes the need for having well-trained, on-the-job supervision, and assistance for all phases of any demonstrations planned. Experiences in many places have shown that the coordinated use of several related technologies into complete and well-organized farming systems may have far greater influence and may form the basis for the pilot demonstration areas earlier described.

Much of the value of demonstrations often accrue from unstructured observations and exchange of ideas among farmers in the area. However, field staff workers may wish to try various organized educational activities to aid in attracting attention and interest. Local experience will indicate those which are most appropriate and successful.

Manpower Training

No development programs can move along rapidly without competent, well-trained people who are available locally to help plan and direct the different programs and projects involved. Several types of training are conceptualized for Tunisian staff members who will be responsible for implementing various phases of the development programs. These include such training procedures as the following:

1. Graduate study abroad for carefully selected Tunisians for special subject matter fields;
2. Short-term technical training in selected locations abroad for future project directors, specialists, and technicians who supervise and work directly in various project developments;
3. In-country training schools, short courses, workshops, and on-the-job apprentice-type training for technicians who will be in charge of various construction and maintenance programs;
4. Long-term USAID assignments of experts (scientists) to work on the job (in the project area) with Tunisian counterparts throughout the development period; and
5. Short-term (TDY-type) assignments sponsored by USAID to assist with special types of training and specific interventions -- including both scientists and technicians (such as specialized mechanics,

machine operators, etc.) with many years experience in their respective specialties.

Research and Extension Support

While several interventions can be implemented quickly in the project area, others require application-type research within the locality in order to assure continuing progress over time. Such adaptations should be supported by thorough on-going research conducted in or near the project area. Likewise, the accumulated information should be transferred quickly and effectively to the large number of individual small farmers in the area -- both those with dryland and irrigated holdings. This requires an effective information delivery system, closely coordinated and demonstrated in connection with the adaptive research in the area.

Rather than propose the development of new research centers within the project area, the assessment team suggests that existing research stations and facilities in nearby locations be more fully and promptly developed to serve the project area. Likewise, it may be wiser to work through the existing extension structure serving the area by providing support for additional facilities, personnel, supervision, training, etc., which may be essential for rapid progress in getting development under way.

Some specific suggestions for enhancing the research and extension services for the area will be noted briefly with further elaboration in later sections of the report.

Research Coordination

Research stations at Ousseltia and Le Kef are near the project area, and both can contribute greatly to development. However, to be most effective, careful planning should be done to assure that the work of the two stations be complementary rather than duplicative.

Perhaps responsibility for directing adaptive-type research in the various delegations could be shared, either on a geographic basis or by specialization in different kinds of research. Whatever the arrangement, a two-phase procedure is suggested for conducting the research needed. Both phases can be implemented and continued concurrently.

The first phase would involve plot-size testing at the stations of new varieties of cereal crops, grasses, and legumes which already have proven successful under semi-arid regions elsewhere with similar soils and climatic conditions. From the great number of varieties tested, selections could be made quickly for extending the plantings to private farms and perhaps public lands in sectors and delegations throughout the project area. These field demonstrations would require careful and continuous supervision by competent field staff to assist with planting, harvesting, and evaluation of results.

Adaptive research in other subject matter fields for specific interventions would be conducted in similar manner. They will be specified in the next section.

Research-Extension Coordination

It is suggested that field workers be assigned a minimum of one in each delegation -- to work directly under the supervision of the Research Station staff for technical, subjective matter information. Administratively they might fit in with the appropriate extension organization which serves the area. The headquarters for each field specialist might be located at the appropriate extension organization which serves the area. The headquarters for each field specialist might be located at the appropriate research station to help assure close coordination. But the major part of his time day-by-day would be spent in the delegations and sectors to which he is assigned for directing the field demonstrations and pilot areas. He would coordinate his activities closely with those of the regular extension workers in the area. Both should work closely and personally with the individual farmers involved. In many cases this would involve actual personnel assistance throughout the task of setting up the field operation -- planning, specific design and layout, application of fertilizer, planting, harvesting, installing pump sets, etc.

This field specialist -- probably of a general farm management (agricultural-engineering type in the European sense) -- would rely greatly on the help of regular extension workers and all agency representatives with educational activities to motivate widespread adoption of the proven innovations.

Subsidy-Type Assistance

Most of the small farmers for whom most of the interventions are proposed, lack financial reserves for investments in new innovations. Many have no basis for credit. While outright financial grants in cash might be undesirable, assistance to motivate adoption of new practices might be provided in a number of ways.

Some of the supplies needed for particular adjustments might be in the form of out-right grants -- in the form of materials rather than cash.

Such items as improved seed, fertilizer, nursery stock for tree planting, etc. could be provided to those who lack investment capital and a source basis for credit.

Probably the most important type of support would be the on-farm help provided by field staff workers assigned to the delegations as earlier explained.

In case of larger investments -- for such items as pump sets, well improvements, stream diversions, etc. -- combination assistance in the form of grant money coupled with long-term loans at favorable rates might be considered.

Water Resource and Soil Conservation Interventions

Irrigation Interventions

Pump sets for shallow wells. A large number of shallow wells exist in Foussana and Thala that need pump sets

before irrigation can be considered. These farms now are dryland farms until pumps are available. At least a few such wells exist in all delegations visited. Time prevented the Team from determining how many local reports are available of wells needing pump sets.

The most immediate impact on agricultural production, living standard, and permanence of settlement can be made by equipping these wells with appropriate pump sets. Single-cylinder diesel engines with close-coupled centrifugal pumps are already manufactured in the industrial zone south of Bizerte. These are appropriate up to a water table five meters below the surface. Electric motors with close-coupled centrifugal pumps seem to be readily available where electricity is available. These can be installed in large diameter wells several meters below the ground surface. Deeper wells will need single-stage turbines with quarter-twist flat-belt drive such as are already used in Jilma Delegation, Jilma and Es Sod Sectors.

Tunisian-manufactured single-cylinder diesel pump sets should be available for 650 D each. Electric pump sets should be available for 500 D each. If these are not available locally, they can be USA supplied, delivered, and installed for that amount. Single-stage turbines suitable for large diameter well installations are manufactured in Europe. Esimate cost of engine and pump unit is 1500 D.

Dalton and Blackton in a March interview at the Office of Employment in Kasserine were told that per-capita income ranked poorest to richest for project-region delegations is as follows: Jedliane, Feriana, Foussana, Kasserine, Sbeitla, Thala, and Sbiba. Feriana and Kasserine Delegations are not considered by the University of Missouri-Columbia team report. Foussana has the potential for the most rapid percentage increase in total income from agricultural development due to the soil and ground water resources readily available for development.

Foussana now needs 130 pump sets for recently constructed or in-progress wells on dry land. An average cost of 800 D would require $25,000 US. There is need for 40 slightly deeper dug wells north and east of Foussana Village about 1 kilometer north of the railroad track. The aquifer is defined and found of low-salt content by DRES. Single-stage turbines would be required at a total cost of approximately $150,000 for the 40 pumps. An area southwest of Foussana will support 30 new wells at $100,000 US for turbine pumps and engines. Some wells exist in Afrane and El Hazza Sectors which border Algeria. We should assume 50 potential wells in these two sectors needing $100,000 for pumping units.

Deep wells. A number of deep wells have been drilled over fifty meters in depth in several delegations that are capped off and have never been used. Deep-well turbine

pumps and appropriate power units are needed in order to utilize these wells. (At the same time, land must be re-assigned to benefit as many families as possible.) The total investment is very high in well, pump and power unit per hectare served. Information on ultimate capacity of the deeper acquifers can only be estimated by water engineers until use-history data can be obtained. It is recommended that these wells be equipped with pumps and power units at an estimated expense of 15,000 D each in order that more information be obtained about ultimate aquifer yield. There is danger of deterioration of unused deep wells. It is not recommended that additional deep wells be funded by this project at this time due to the total cost per family directly served and the lack of historical data on pumping from the deeper aquifers.

Spring development. The team visited springs in Bouderiass Sector of Foussana Delegation, Ain Oum Jdour Sector of Jedliana Delegation, and Dachra Sector of Thala Delegation. Several other springs were reported to the team and DRES reports contain flow-rate information. These springs can only benefit a few families each, but where they are properly utilized they greatly benefit the families served. All such easy sources of water should be utilized to the maximum. In nearly all cases a masonary reservoir of 50 to 100 cubic meter capacity, and lined channels, would

increase the efficiency of use, decrease deep percolation losses, and permit additional families to be served. Each spring presents a unique set of options for improvement requiring individual planning.

Underutilization of irrigation water. A number of studies have been made by various AID and FAO experts of underutilization of proven irrigation. Several simple technical problems can be quickly solved where there is an incentive toward better management. Social hindrance to development of additional irrigated hectareage may also be limiting the rate of development. Examples of technical limits on proven water supply utilization are:

1. Land leveling assistance needed to get fields in shape so animal power can till the land for best water distribution;
2. Credit needed for pump set or usual irrigated-agriculture inputs;
3. Hired day-labor shortage in a particular season;
4. Distance of irrigated hectareage from owner's dwelling;
5. Policy of restraint by managers of large projects where irrigation is only allowed to the limit of summer season capacity; (A tremendous increase in forage production could be made by cool season irrigation of additional adjoining hectareage.)

6. Policy of restraint on the part of DRES technical staff due to honest concern that aquifer not be over-exploited.

Social restraints on maximizing ground water utilization may include:

1. Investment cost whether private or government subsidy;
2. Education for changing life patterns from livestock herder to irrigated crop cultivator;
3. Financial incentive for government technical and administrative staffs to push development.

Retention Dams

Confusion over definition of water retention structures, stock ponds, diversion dams, and "small-scale irrigation impoundments" has been evident in tri-lingual communications between USAID project planners, the UMC team, FAO representatives, Tunisian technical people in CNEA and DRES and Tunisian administrators, such as project area delegates. Sites shown to the evaluation team invariably showed need for water spreading on nearby land, need for water storage, and defined runoff channels from nearby mountains. In every case there was bountiful evidence at hand of an excessive amount of sediment from silt to small boulder-size particles already present at the site. Any reasonable size structure could be expected to fail due to sediment deposits within five to ten years. An unusual rain could completely fill a structure with sediment in one storm event.

Water in Tunisian agricultural development is limiting. Rainfall in the Central Tunisian Project delegations visited is variable in long-range means as to locations due to orographic effects. Lee sides of mountains (east and south faces) are in a rain shadow and may receive one-half the rain of the northwesterly exposed upwind mountain faces. All of the region has a wide range of seasonal and annual rainfall amounts around a particular location's individual mean rainfall. The fall of 1967 through winter of 1978 season has been particularly dry. Many farmers visited reported much less than half of normal rains for this season.

Surface runoff is rainfall dependent. Surface runoff available for retention and storage always varies more erratically than rainfall. Annual runoff is estimated at less than 15 percent of rainfall means throughout the area. Runoff available after storage for use in a later season from typical "small" watersheds in the project area will vary from 7 to 0 percent.

Cost per irrigated hectare for irrigations from small retention dams can be expected to be 4 to 10 times the cost of developing dry hectares for irrigation from wells where shallow wells (less than 30 meters depth) are feasible. In addition, there would only be 10 to 50 percent probability of water available from storage, whereas most well water supply approaches 99 percent probability of availability when needed.

Rock Dams Or Gabions

Channel obstructions of rock of sufficient mass to retain its position during peak rate of runoff events and of sufficient porosity to eventually pass all retained water are useful devices for increasing ground water recharge. When such channel obstructions are coupled with diversions to greatly increase channel flow path, then both intake area and intake opportunity time are greatly increased. Many places in the world already use such devices for ground water recharge, notably Southern California, Arizona and New Mexico. The Forestry Department of Tunisia uses channel obstructions of rock held together by wire mesh (gabions) as channel grade stabilization devices or to provide tiny basins to encourage young trees. Channeling runoff flows at right angles to stream slope would be a useful addition to these devices in rocky areas above proven ground water acquifers.

There is no immediate measurable increase in monetary return to irrigated hectareage from increased water percolations. The long-range benefit to a local society is to allow increased duty on a proven aquifer downstream from the recharge site.

Unless a series of rock dams along a channel start near the top of a watershed, they will be overwhelmed by the mass of sediments during intense rainfall events. Geologic erosion in mountain areas can be expected to continue through the foreseeable future in Central Tunisia. Rock dams have no

real potential for water storage for irrigation except where they may be used as sediment traps and sediment-reduced water is diverted to off-channel storage sites.

Large Impoundments

The boundary of Ouled Mahfoudh and El Mziraa Sectors in Foussana Delegation at the southern end is Oued Charchara. A site there has been studied by FAO and DRES engineers. Apparently there is the potential for a single-structure storing irrigation water sufficient for up to 1,000 hectares. Irrigated lands could begin with 3 kilometers downstream from site. Cost would be in the 5 to 10 million dollar range. The impoundment would be supported by a spring-fed perenntial stream of about 30 to 40 liters/sec. Watershed information is on file with DRES-Kasserine. If serious consideration is given to this single-impoundment project, a foundations geologist from the Bureau of Reclamation, Denver, should visit the site for inspection of the horizontally stratified rock formation.

Another site visited was on Oued Adhira southwesterly from the junction of GP13 and MC91 in Foussana Delegation. The site appears appropriate for construction of a dam and the channel obvoiusly carries large amounts of flood waters for short periods of time from the 147 square kilometer watershed.

At both sites flood protection would be of low value below the site due to the undeveloped nature of the site.

Ground water recharge would be of very high value in a long-term analysis, but would be very difficult to identify.

At least one potential storage site of this magnitude could be identified in each delegation. Runoff data is scarce. The probability of failure as reliable irrigation source is high. The Foussana-Chachara site is unique as to the spring-fed perennial stream.

The master plan for surface and ground water development for Central Tunisia, based on the Central Tunisian study of 1963-68 and subsequent update studies, was published in February, 1977. It includes rainfall, runoff, and climatology data and data about potential reservoir sites. It also includes proposed construction schedules for the next few five-year plans.

Water Spreading and Erosion Control

Sloping dryland areas need to take advantage of all possible available water for either cereal or forage production, both where cultivated annually and where under permanent cover for pasture. A large number of terraces have been constructed with hand labor as make-work projects by the GOT Forestry Department since 1957. Many of these systems have failed due to poor cross-section of terraces (tabia) in original construction, no maintenance after major storm events, or poor attention to gradient of the terraces channel. These observations intended for cereal, tree and grazing

land with less than 8 percent slope. Recently a few systems of terraces (tabia) are being constructed with adequate ridge height, but still with steep faces preventing utilization of the terrace ridge for cropping.

Level storage terraces should be constructed capable of storing from 7 to 10 percent of expected annual rainfall. Such storage terraces will increase root zone water available for cropping. Properly spaced at 25-45 meter spacing (land slope dependent), such systems will dramatically reduce soil erosion as well as provide extra water for crops.

Where the terrace system can be extended to the upper reaches of a very small watershed or a large diversion can be constructed above a planned set of terraces, all of the runoff in dry years can be spread with terraces (tabia) on cereal land. Cost benefit ratios are difficult to forecast without actual case studies or pilot demonstrations. It is safe to assume 15 to 20 percent increase in forage or grain production in years of above normal rain (compared to unterraced areas) and 50 to more than 100 percent increase in production on terraced areas in the driest 2 years of a 10-year period when complete crop failure can be expected and is being experienced on unterraced land.

Land which will benefit most from these systems of terraces (tabia) is cereal-capable land with long moderate slopes of 2 to 5 percent gradient. Terraces can be up to 500 meters in length. For most of their length they will be

level for storage. Ends would be closed. Water would be diverted from small channels. In some cases cross berms might be constructed where tractor plowing is not anticipated.

Where diversions are necessary to divert runoff from steeper land above the cereal land, the diversions must be constructed with sufficient cross-section to divert the flow away from the terraced area to permanent channels. These diversions will need silt basins at points where they cross smaller existing channels. De-silted water may be impounded along diversion channels, but not in reservoirs constructed on natural channels that carry large amounts of detritus during storm events. Off-channel storage ponds for stock water was not witnessed by the team.

The usual planting pattern witnessed by the team for tree crops has been rectangular without regard for land slope. One or two exceptions to this common practice have been observed where a good system of contour terraces (tabia) were constructed and the trees were planted on contour with one row of trees in the terrace channel to take advantage of the increased water available. Other trees between channels were also contour planted. This allows contour plowing and cultivation of inter-planted cereal or forage crops.

All plowing and planting on land slopes greater than two percent should be on the contour, especially tractor plowing. Permanent tree crops on contours in lieu of the

present rectangular grid would allow inter-planting of forage or cereals and contour plowing for all cultivation. A 1956 decree of the Government of Tunisia requires all plowing to be done on contour or fines are to be assessed. It is not enforced. SCS now insists on contour tree planting where Forestry provides technical assistance.

Tunisian agriculture has used a system of runoff spreading in the past called "M'goud" or "meskats" in Arabic. The essentials of the system are to divert runoff from ephemeral stream channels along a man-made channel with gradient flatter than the natural channel so that after some distance the water so diverted is above the adjacent field elevation. The water then is turned from this constructed channel onto cereal or tree lands, ususally between terraces (tabia).

This system requires large amounts of hand labor to work in the wet fields during and immediately after rainfall. Under tribal and large cooperative organization, the labor might have been available. Under individual ownership of small tracts, all such systems visited by the team had failed due to sediment accumulation in the channels and rupture of the fragile berms of the conveyance channels. For this reason it is not a recommendation by the team that USAID funds be invested in this system of water spreading. The concept is excellent. The practice, if followed, would benefit annual crops and contribute to ground water recharge. The difficulty in practice is that of social organization.

Preferred systems of water spreading are those that keep the runoff area small and the potential for damage small during unusual peak events.

Assessment of Available Technology

The current technological situation in the Central Tunisian area studied by the UMC-AID team is surprisingly strong. The ability to discover pertinent technical reports was limited only by time and the UMC team's ability to ask pertinent questions. Repeatedly when the team asked for technical information on soils, ground water, wells, pumps, terrace design standards, etc., the Tunisian office would come up with a report, thesis, or study completed last year or "very shortly." The bibliography attached will not be complete or exhaustive because of time limitations. Hopefully, it will be completed later by CNEA staff for use by AID-Tunis.

The large number of these reports available through CNEA, DRES, Genie Rural, and other agencies indicates a serious concern on the part of Tunisia's technical cadre with the major restraints on agricultural capacity. The number of studies recently completed and nearing completion indicate a "turning point" in time. It is time to move from study to action. One of the most encouraging features of agricultural technology transfer is the involvement of research and action-agency technical people in classroom teaching. This now needs to be expanded to adult continuing education.

Suggestions for Future Research and Action Programs

A number of deep drilled wells have been constructed in the last five to ten years in several of the delegations. These need to be equipped with pump sets and hour meters so accurate estimates of total use may be recorded. DRES engineers need the use and drawdown data so as to refine estimates of acquifer parameters before drilling additional deep wells. Agriculture needs to establish a use history of the deeper aquifers before the coastal cities lay claim to the acquifer as has already happened to one of the Jilma aquifers. (A one cubic meter per second pipeline to Sfax from Jilma is nearing completion.)

A few areas exist where galleries may be driven into or through mountains to intercept pockets of water which may be conveyed by gravity to points of need. A mine in Djebel Chambi is reported to produce sixty l/s without drawdown. A French-constructed railway tunnel in the Tbaga-Haidra area of Thala Delegation encountered so much water that major effort was required to seal this water off from the tunnel with a concrete lining. Plenty of land exists in Foussana basin to absorb such a flow from the Djebel Chambi mine and others that might develop. Springs on the northwest face of Djebel Semmama indicate presence of a considerable body of water. The southeast face of Djebel Semmama is a critically dry area where water is needed for human and livestock needs. Springs in Medliana also indicate need for

study and development to maximize use. A plan of action to exploit these types of water resource needs to be formulated.

Schedule C graduates need to be in the field at work on terracing and small-scale water diversion projects. Short-term TDY trainers from the midwestern-associated universities might conduct in-country on-the-job training camps for a small cadre of such graduates who would be ultimately or already employed in Genie Rural, Forestry, or Extension. A major effort needs to be made for first-quality systems of terraces to harvest additional water for immediate use and to conserve soil for generations as yet unborn. (It should be noted that Genie Rural no longer has responsibility for tabia construction supervision. SCS of Forestry now provides technical assistance on public and private land where soils and rainfall are deemed suitable for cereal production.)

Infiltration galleries along stream channels are not common in Central Tunisia as water sources. One private well was visited in Chefai Sector of Thala Delegation where a direct open intake from a very small perennial stream supplied the "well." A small (inadequate) gasoline engine driven centrifugal pump delivery water to the level of the irrigated field on the Oued bank. Another well visited in Bouderiass Sector of Foussana had water within two meters of ground surface. It obviously was supplied by the adjacent stream channeled by underground flow.

Genie Rural should help farmers locate sites where streams have at least trickle flow eight to nine months of the year and where excavations of one to three meters depth below streambed can be readily made. Masonry well casings reaching above anticipated floods would be easy to construct on such sites. Openings through the masonry below streambed height would allow infiltration of subsurface stream flow. In addition, DRES should investigate horizontal intake galleries in large stream channels using well screen where a trench can be excavated below streambed level two to five meters in depth and graded backfill used to insure adequate infiltration.

The engineer on the team was not able to discover the means of knowledge diffusion to the farmers. The studies of areas of ground water availability should be diffused through extension and administration so that farmers have a better knowledge of what may be possible. Terrace systems should be planned only with the owner/farmer's active interest and involvement. All soil conservation and water spreading structures needed to be planned only where farmers clearly understand their function and where they are committed to proper plowing and other maintenance within their abilities so that the systems may function as designed for many years.

Water supply for human and animal needs should be a high-priority effort. Technicians need to be more daring in exploring fringe areas of known aquifers. The place of cisterns and small capacity deep well piston pumps needs to

be seriously considered based on existing data. Action teams adequately motivated need to be placed in the field equipped to operate in remote areas.

Future research should emphasize efficiency of water use for these areas where water is limiting. Tree crops, for example, need a sure water supply the first two years. Long-range planning may need reliable research information on drip irrigations and other technology that maximizes water-use efficiency. At the present time, these sophisticated irrigation methodologies are inappropriate to the process of converting dryland herders to irrigated farmers. They will be appropriate to the next generation, possibly as soon as ten years hence.

A combined effort of CARE, Peace Corp, and USAID should be made to develop small wells (four inches or less) for human needs. Efforts to develop wells should be made in areas without proven water where risk of failure is high and where additional knowledge of low-yielding water supplies is needed. Lifts of more than 100 feet from well depths greater than 200 feet become feasible when the alternative is surface-runoff supplied cisterns for only part of the year and eight to ten kilometer walk the remainder of the year. Tunisian agencies that might cooperate include DRES, OTD, SONEDE, COCEMO and the social service agency now counterpart to CARE.

Soil Fertility, Cereals, and Forage Interventions

Introduction

The science of agronomy defines the relationships between the rate and amount of plant growth and levels of available nutrients, available soil water, soil air, solar radiation, and air temperature; these later factors describe a plant's environment. In fact, a green plant is a factory using the raw materials of plant nutrients, oxygen, and water, with energy from the sun, to manufacture proteins and carbohydrates necessary for its own vegetative growth and reproduction. When the amounts of all the raw materials are at optimum levels, the plant will attain its maximum weight of vegetative material and reproductive organs (seeds, tubers, etc.). In the case of perennial forage plants, in addition to producing seeds, they need to store carbohydrates in their roots in order to start the next season's growth. If grazing management does not allow this storage, the plants will eventually disappear from rangeland.

Animals use plant vegetative and reproductive parts directly for food; humans also use plant parts (seeds, roots, tubers) directly and indirectly by using animal products (meat, milk, eggs, etc.). Consequently, the vigor and amount of plant material produced per unit of area has a direct relationship to the number of animals (humans, sheep, cows, etc.) that can be supported by that area. An understanding

of the above-mentioned relationships is vital to the solution of the problems of the dryland farmers of Central Tunisia.

Central Tunisian dryland farmers depend primarily on livestock and cereal grains for their own food and marketable products which are exchanged for other necessities. Fruit and nut trees are sources of food and income for some dryland farmers but these sources are not included specifically in this portion of the Central Tunisian Study.

Rangeland

The problem. Over fifty percent, the actual amount is not quantified, of the surface area of Central Tunisia is considered rangeland on which a very large number of sheep and lesser numbers of cattle, donkeys, horses and camels barely survive. The sparse rainfall in Central Tunisia, 250-450mm per year, for centuries supported only limited quantities of forage and nomadic movement in search of food for their animals was the experience of most Central Tunisians. Many of these families grew crops of cereals in addition to their livestock. Gradual increases in population and the concurrent increase in livestock numbers increased the grazing pressure on forage plants.

The increase in hectarge of wheat and barley in recent times due to the introduction of tractors and combines made these cereals items of commerce and sources of cash money.

The consequent result of increased cereal production was a reduction in grazing areas. This forced the increased numbers of livestock on to the decreased range area thereby increasing grazing pressure on a naturally fragile ecosystem. The result was the collapse of the system with the only surviving palatable species being small annual legumes and grasses such as lotus cilysiodies, coechrus ciliaris and a few semi-palatable perennial species such as retama retan, a legume. Consequently, the large numbers of livestock barely survive in the better rainfall years and resort to spineless cactus in bad years maintained by government-subsidized feeds, are sold, or die. The attendent result is a constant precarious subsistence for herdsmen and their families.

The solution. The only alternative to the condition of Central Tunisian herdsmen other than constant supply of food and other necessities from outside sources is Rangeland Management. Bell (1973) defines Range Management as:

> the practical application of a science dealing with the vegetation that is suitable and compatible with the environment that characterizes a given kind of rangeland.

In the case of Central Tunisia, the rainfall is limited and individual rainstorms are sporadic. Hail is a common threat. The rangeland soils are mostly silt loams frequently of shallow depth, often stony, and, in some areas, sandy. Summers are hot and winters are cold especially in the higher elevations. Available plant nutrients are presumed to be low,

although the quantities present may well support the amount of forage growth the soil moisture will permit. The present palatable plants are annual which respond to "rotational," "deferred" or "managed" grazing. But these annuals are low yielding and have short life span. To gain maximum benefit from the poor rangeland pastures which are difficult to manage high yielding, palatable perennial grasses must be introduced. Such grasses have been tested and established on other overgrazed lands in other semi-arid parts of the world e.g., Southwestern United States (University of Arizona, 1957, 1960; University of New Mexico, 1965; Soil Conservation Service, 1965). Many of these grasses have been tested in Morocco (Institut Nationale de la Recherche Agronomique, 1963) and could be planted on demonstration areas in Central Tunisia. September would be the best time to plant such demonstrations. Meanwhile, other grasses with similar adaptions should be planted on test plots in several places to discover even better adapted species (Huss, 1977); there are state farms (e.g., Denglas Perimeter) which are possible locations as well as on farms of larger interested landholders. Such plots, hopefully, would be managed by government employees within the structure of the Ministry of Agriculture with oversight from a rangeland specialist associated with the Arid Lands Institute. The demonstration areas would need to be large enough to provide for managed grazing with a flock of fifty or more sheep. It has been observed that

herdsmen do keep animals out of restricted areas so the problem of keeping test plots and demonstration areas free of animals is not an insurmountable one.

Hopefully, increased grazing land could be obtained by returning fields of less favorable soils now in barley and olive trees back into rangeland through reseeding to perennial grasses. How this could be done is uncertain, but there are many hectares believed to be unprofitably planted to barley and olives which could be in grazeable forage. Presently, such a practice is not possible, one reason being the unavailability of adapted grass seeds. Also suitable data showing the advantages of such a change are not available in Tunisia.

Another source of forage is biannually rotating medics with barley on soils where continuous barley is not profitable. This program, when properly practiced, supplies excellent nutritious forage every other year, keeps a supply of medic seed in the soil thereby making its reseeding unnecessary, and supplies some legume-fixed nitrogen for the barley crop. At present medics are not considered adapted to the low rainfall conditions of Central Tunisia but two and three year stands exist in the Maktar area and on the Ousseltia research center where the rainfall is 520 and 350mm, respectively.

Approximately six hectares of Harbinger medic occur near Maktar and forty hectares have been planted successfully

at the Ousseltia state experimental farm. Also, approximately twenty hectares of medic planted on private land in the fall of 1977 was noted about seven kilometers west of the Ousseltia center. A good stand was obtained and some seeds had set by March 16, 1978, despite lower than normal rainfall.

A medic cultivar, Tortulis, is available which is even more drought-tolerant than Harbinger. The observations in the Maktar and Ousseltia areas indicate that medics could be utilized in areas of lower rainfall than originally thought. Testing of these and other strains and varieties in such areas could be started in September, 1978.

The solution to the condition of the Central Tunisian dryland herdsmen is a long and complicated process but enough is known to make a start without further delay. Availability of seed of adapted grasses (Curtis and Curtis, 1977; King, 1977)) and legumes (e.g., Harbinger medic) should be determined and plans for planting test plots and demonstration areas should be developed.

Dryland Cereals

The problem. There are basically two problems involved with dryland cereal production in Central Tunisia: (1) planting barley on soils unsuited for it and (2) availability of plant nutrients, especially phosphorus, applying both to barley and wheat.

Barley production has increased, as discussed under Rangeland, since 1969 due to the Tunisian government's intent to increase food and feed grain supplies. Barley production in 1975 was 260 thousand tons; a production of 350 thousand tons is planned for 1981 (Fifth Plan). Also barley prices have tended upward (Bale and Andre, 1977). The result has been the increased planting of barley on marginal soils. The small patches of barley high on the mountains and on very stony and sandy areas are evidence of this. Also the plowing up of alfa grass to plant barley is an item of concern to the government and the paper production plant in Kasserine. Included in this problem is the planting of barley cultivars unsuited to dryland conditions.

The solution 1. The solution to the problem of barley being grown on low quality soils is the same as that of the dryland ranges, i.e., seed to more productive perennial grasses and promote range management. This is not an easy solution for it entails the testing of rangeland grasses under Central Tunisian conditions, effective test demonstrations on government farms or farms of cooperative landowners and vigorous extension efforts. This will be a long-time program but effective aid can be had from the CNEA soil scientists who can delineate soils as to their suitability for either production of barley or rangeland grasses. Demonstration areas could be set up using crested wheat grass while effective test plot results would later

identify presently known cultivars that are better than ones now grown. Also the work of the Institute should be enlarged to develop cultivars better adapted to the barley-growing areas of Central Tunisia.

The solution 2. The problem of identifying the available phosphorus needs of cereals as well as the effectiveness of small amounts of nitrogen on dryland grain production is also complex but potentially can be solved in shorter length of time than the problem of suitable range management.

Two agronomic principles are involved: (1) plants having access to adequate available nutrients will use limited amounts of soil water more efficiently than plants deficient in an available nutrient but exposed to the same amount of soil water; (2) the non-availability of phosphorus in a calcareous soil. Observation of barley and wheat growth in Central Tunisia suggests that both nitrogen and phosphorus could be limiting plant growth. Generally, Central Tunisian farmers do not fertilize barley due to the hazard of drought and the broadcast method of applying ammonium nitrate and superphosphate. Also the recommended rates were determined where rainfall is not limiting. The localized placement of small quantities of ammonium nitrate at planting time might encourage the growing plants to produce vegetative growth which, if the season proved to be a dry one, could be used for animal feed. If the season was one of normal rainfall or above, then the greater vegetative growth would be utilized in greater

grain production. The effectiveness of small amounts of ammonium nitrate at planting time could only be determined by applied research in carefully controlled test plots.

The problem of the availability of phosphorus in high calcium soils is more complex. The following is an explanation of this complexity. Practically all soils in Tunisia contain free calcium carbonate which, in moist condition, to a small degree reacts as follows:

$$3\ CaCO_3 + 6\ H_2O \longrightarrow 3\ CA^{++} + 6\ OH^- + 3\ H_2\ CO_3$$

$$3\ H_2\ CO_3 \longrightarrow 3\ H_2O + 3\ CO_2 \text{---}$$

The active plant nutrient in superphosphate is phosphorus which for simplicity can be illustrated as being in the form of phosphoric acid:

$$2\ H_3\ PO_4 \longrightarrow 6\ H^+ + 2\ PO_4^{---}$$

The free calcium ions, 3 Ca^{++}, from the above equation, then react with the 2 free PO_4^{---} ions to form tricalcium phosphate $Ca_3\ (PO_4)_2$ which is relatively insoluble and tends to make phosphorus a limiting plant nutrient in calcereous soils. The $6\ OH^-$ ions of the first equation gives the soil an alkaline reaction, a pH of about 8.3. The method of solving this problem is localized application of superphosphate near the barley or wheat seeds at planting time. This practice places a relatively large amount of superphosphate

in contact with a relatively small amount of soil while the practice of broadcasting and working into the soil places a relatively small amount of superphosphate in contact with a relatively large amount of soil. In the former case, small quantities of superphosphate will supply adequate phosphorus for plant growth while the latter method tends to provide a shortage of phosphorus.

The evaluation of these two methods of applying phosphorus needs to be done through carefully controlled applied research using varying amounts of superphosphate on different plots. The available phosphorus in the check plots can be determined by the method of Olson et al. (1954). This method is used in determining the available phosphorus level of the high calcium soils in the Western United States. By knowing the available phosphorus in any one soil, after the applied research is completed, then the quantity of superphosphate to apply as a local application can be easily determined.

The evaluation of the amount of ammonium nitrate and superphosphate to apply to both dryland wheat and barley can be done with simple one row planters, the only qualification is that the planter design will permit both fertilizer and seeds to be placed at the same time. The twenty-hole grain drill ordered for the Siliana Project could be used as it also contains boxes for grain seed and fertilizer. This drill could be used by blocking off groups of six holes in the fertilizer box and placing in these sections different amounts of ammonium nitrate and superphosphate to which

should be added different quantities of some inert material so that the total volume of material and fertilizer for each treatment is the same. It would not be a difficult job to calibrate the Siliana Project drill so it could be used in this manner. The fortunate circumstance of this drill is that some applied research test plots could be initiated in September, 1978.

Many Central Tunisians are accustomed to using grain drills without the fertilizer attachments. If it were found that banding fertilizer were a profitable method of fertilizing cereal crops, drills with fertilizer attachments could easily be obtained though a bit more expensive. Small five- or six-foot drills for the smaller farmers are available from Northern European countries, Sweden, etc. These drills are made to be pulled by a single horse. It may take two donkeys to pull one of these in Tunisia. The fact that both large and small drills are available makes the localized application of plant nutrients possible.

Suggestions for Future Applied Research and Action Programs

Applied soil fertility studies. Observations indicate that applied soil fertility research has been lacking in Tunisia. Apparently the broadcasting of chemical fertilizers was investigated by the French and their recommendations are being followed in the main. The concepts of available plant nutrients and their measurement have apparently not been

developed to any degree. Thousands of chemical analyses have been made on soils, useful in characterizing the soil types for soil classification purposes, but of very little value for the purpose of determining the quantities of available phosphorus and potassium. The need for potassium is possible on sandy soil, especially where large crop yields are produced by irrigation or in Northern Tunisia.

The Le Kef Institute is considered near enough to the project delegations to serve the area with an applied research program. The current assets of the Institue include a well-trained and enthusiastic director, Dr. A. Daaloul, and a barley research scientist, Dr. M. Harrahi, who is interested in resident work at the Institute if adequate research facilities are provided; access to the use of at least 1,500 hectares of school land suitable for field research; adequate building space for seed and soil testing laboratories, office, workrooms, etc.; and an associated training institute which can provide student assistants for carrying out much of the detail work needed as a part of their specialized training.

Greatest needs of the Institute in order to be of service to the project area in the near future include complete facilities and equipment for soil testing and seed laboratories, field equipment adapted for working and harvesting research plots, additional scientific and technical

personnel, and training and assistance in expanding the types of adaptive research needed in the area. [redacted]

Another institution which could also contribute to the adaptive research efforts is the INRAT Experiment Station at Ousseltia. The Station has 1,850 hectares of land available for carrying on various kinds of agronomic research with present concentration on barley. The type of land and other conditions are representative of much of the project area (with approximately 350mm of rainfall annually) and research at the Station would be applicable -- especially if coupled with extensive adaptive research trials and demonstrations in different delegations of the project area.

The director of the Station, Dr. Ben Abdallah, is well-trained and interested in expanding his research efforts if improved facilities and adequate supportive staff -- both scientific and technical -- are made available.

It is recommended that high priority be given to the establishment of a soil fertility and soil testing position. The first item would be the development of an individual well grounded in chemistry with application to the chemical process in soils well understood. Such a person might best be obtained in a M.S.-degree graduate at an American institution, such as Colorado, who would spend at least two years working on his degree. For best results, the candidate should have a good command of spoken and written English before

starting his studies. It would be most profitable for the major advisor of such a candidate to spend a week or so in Central Tunisia in order to appreciate the local soil fertility conditions. Also it would be profitable for the candidate if the problem under study for the M.S. degree were carried out under conditions in Tunisia. It is envisioned that test plots would be established in several areas including the drier conditions in Central Tunisia. This would entail the candidate spending some time in Tunisia getting hopefully two years' data which would be time well spent with the data already applicable to Tunisian soils. If the above-mentioned program were used, two or three hand-picked members of the Tunisian extension service could be selected to assist the candidate in the collection and processing of data. This would mean the training of these extension workers at the same time the candidate was getting his degree. There is really no substitute for such applied studies being carried out where the candidate will eventually work. It is recommended that USAID give serious consideration to supporting such a candidate.

While the above-mentioned Tunisian is being trained in soil fertility and testing techniques, it is recommended that USAID provide a technician who would help Dr. Abderrazak Daaloul develop plans for soil fertility studies on the lands of the Cereals Institute and for soil fertility and soil testing laboratories in the building at his disposal. It is

believed this technician need not move to Tunisia but by several trips of two- to three-weeks duration could be as effective as being on the ground for the two-year assignment.

Applied range management studies. Of equal importance to Tunisian dryland agriculture is the testing for adaptability of perennial rangeland grasses under Central Tunisian conditions and determining how best to establish them on overgrazed land. The results of tests in Morocco should act as a guide as to what species could be adapted to Central Tunisia. The development of a rangeland management position associated with the Arid Lands Institute is also recommended and that USAID consider the support of such a program. The person in charge should have at least M.S.-degree training obtained as outlined for the soil fertility and soil testing position, possibly at Utah or Arizona State University. The establishment of high-yielding rangeland forage species and their management will be a difficult task but land is available on state farms and extension personnel trained at the same time as the M.S.-degree candidate should be effective in starting such a program. As outlined above for the soil fertility and soil testing program, a range management technician should be obtained by USAID to start plot and demonstration work using the expertise of Dr. Novikoff, DeReath Palmer and D. Gault. These plots could be part of the M.S. candidates' research problems. The availability of

the Siliana drill should help in planting demonstration areas. One item of study would be methods of establishment of range grasses on farmers' land. The method of inducement to get Central Tunisian herdsmen to plant such species and manage them properly would be the prerogative of the Tunisian government. It is believed this is not an impossible problem.

Improved dryland barley cultivars. This barley selection and breeding program at Le Kef could be started under the guidance of AID-trained personnel, Dr. Abderrazak Daaloul and Moncof Harrabi. Both of these men are well trained in small grain breeding techniques. USAID personnel should keep these persons in mind and encourage them and their supporters whenever possible. Certainly improved dryland barley cultivars could add to Tunisia's production of food and feed grains.

It is believed the above three suggested items for action should be given high priority in its plan of implementation by the Central Tunisian Rural Development Project. Their vigorous pursuit will mean an increase in agricultural productivity (meat, feed and food grains) and, in turn, an increase in agricultural income without which all other facets of rural development are difficult to achieve.

Additional Enterprise Interventions

Several other enterprises contribute to the productivity, income, and well-being of farm families in the project area. Predominant among these are various livestock enterprises (especially sheep), arborculture, and apiculture. In addition, some production from the land can provide supplemental income from handicraft enterprises -- such as esparato grass for purses, mats, baskets, etc. and various wood novelties from olive wood.

Livestock Enterprises

Several livestock enterprises make substantial contributions to the economy of the project area. As shown in Appendix Tables 11 and 12, the sheep enterprise is predominant and seems best adapted to the sparse and low-quality forage available in most areas. Some goats are grazed with sheep in many flocks since they graze on some plants not palatable for sheep.

Numbers of sheet and goats in the project area already exceed the carrying capacity of the forage produced with present systems of management. Overgrazing is almost universal and seriously reduces productivity, destroys perennial grasses and legumes, and accelerates soil erosion and depletion.

Cattle numbers are relatively small in most delegations and, for the most part, appeared low in productivity -- probably because of the shortage and low quality of forage available. Very little potential for increasing cattle numbers

and production seems to exist, with the possible exception of some irrigated units where high yields of top-quality forage can be produced. Even on these farms, the small quantity of feed available probably will limit milk and meat production primarily to meet the needs for family consumption rather than for sale.

While not a direct assignment for this team several livestock interventions can enhance the total productivity of the project area. Foremost among these are some arrangements for controlled, rotational grazing on rangeland pastures. Preliminary data from studies in the Sbeitla Delegation irrigation perimeter indicate that pasture carrying capacities for sheep may be trebled by rotational grazing alone. Additional application research is needed to investigate the results from combining controlled rotational grazing with reseeding of adapted perennial grasses and legumes.

Several other interventions can improve the productivity of livestock. More accessible water supplies is a primary need and expansion of projects to construct cisterns, wells, and small reservoirs -- both for human and livestock water -- car pay good returns. Additional dipping vats to aid in controlling external parasites also could increase production. Experience with existing projects of this kind should indicate the desirability and economic feasibility of expanding such construction. While plantings of spineless cacti can provide survival feed in times of severe drouths (and perhaps should be expanded in some areas), demonstrations and application research projects could be established to evaluate the economic advantage

of harvesting and storing different kinds of roughage to provide similar insurance. This also might aid in controlling overgrazing and in minimizing weight losses and starvation in times of extreme drouth.

Work animals also play an important role in the economy of the Central Tunisia area. Appendix Table 13 provides some data on numbers of horses, mules, and camels but comparable data by delegations were not available from the source for donkeys. Actually, the small donkeys are the most numerous and versatile of any work animals in the project area. They are used for transport, field work, and almost every conceivable task requiring animal power.

A graduate student's recent study of the characteristics and requirements of various kinds of work animals provides interesting and useful information. Some preliminary data from his thesis study are included in Appendix Table 17. Additional economic data also are included in the analysis as a basis for constructing financial budgets.

Because of small farms, fragmented tracts, and the dearth of investment and operating capital, any significant expansion of mechanized farming seems highly unlikely in the foreseeable future. Hence, further studies to make more effective use of available animal power seems highly desirable.

Arborculture

Many low-income small farmers in the project area can enhance their earnings from well-managed tree plantations of many different kinds. This already is demonstrated throughout most of the delegations.

Where irrigation water is available, a rather wide selection of tree fruits can be grown successfully. During visits to the various delegations in March, excellent plantings of apricots, apples, pears, plums, almonds, olives, and others were observed -- some in full bloom. Apples do quite well in certain areas where soil and climatic conditions are uniquely favorable and are considered most profitable where adapted. Olive plantations are most widespread throughout the area and provide a good source of supplemental income, especially in dryland areas where alternatives are quite limited. However, the GOT discourages new plantings because of the prospects of over production for available markets.

Probably the most promising, and profitable, tree plantations for dryland areas are almonds. They offer a number of advantages, aside from being most profitable according to available budget data. The trees are drought-resistant after they become established (some additional water is needed during establishment); they start bearing within five years after planting; and, cereal crops can be inter-tilled the first three years after planting.

Pistachios also can be grown under dryland conditions, as well as olives, but they are more difficult to establish and are not as profitable under existing conditions. (Prices are high but they do not yield as well).

Sample budgets for a few tree crops are included in Section C of the Appendix.

AID interventions to stimulate expansion of tree plantings by low-income farmers in the project area, both on irrigated and dryland farms, can have substantial impact on the economic welfare of individual families and on the total productivity of the area. Introduction of almond tree plantings on small, dryland farms seems especially promising, since few alternative enterprises are available for enhancing family income.

Most essential AID and GOT assistance probably would be in the form of special training and personal supervision in planting, pruning, harvesting, and general management of the new enterprise. Other assistance could include nursery stock, fertilizers, spray materials, etc. -- probably in the form of material grants until the new plantings start producing and generating income.

Similar types of assistance would be appropriate for other arborculture interventions, either in irrigated or dryland areas.

Apiculture

Many families live in very dry upland areas where soil and rainfall conditions preclude major improvements in land productivity. Much of this land is adjacent to state-owned forest land where extensive clusters of wild rosemary are growing. Rosemary is distinguished by a very long blooming season and is an excellent source of nectar for honey production. For this reason, it is proposed that serious

consideration be given to developing beekeeping operations in selected parts of the Central Tunisian region.

Actually, beekeeping on a small scale already exists in some scattered parts of the area. Until recently, honey has been imported due to the shortage of local production and the high demand. However, with the advent of a college-level teaching and research program in apiculture under FAO sponsorship, production has increased so that the country is nearly self-sufficient in honey supplies. Despite this situation, prices continue at a level too high to stimulate higher consumption which might materialize with somewhat lower but still profitable price levels.

The time seems ripe for an action program involving adult education (extension); starter sets of bees, queens, and equipment; and the creation of a system to move the honey from the producing areas into the urban and international markets.

It must be stressed that this intervention will require an extensive educational component over a long period of time. Bees, whether produced under traditional or modern methods, require careful and educated management in order to preserve hive strength and future potential during the drouths which occur frequently throughout the region. In addition, beekeeping will have to be "sold" to the people of the area, particularly the young. The income potential for a family with a number of hives is quite high and could rise to near

the Tunisian national average within four years if progressive management techniques are employed. Also needed will be mobile processing units to work with the producers at the time of summer harvest.

Specific AID interventions might include short-term TDY experts in the practical side of beekeeping; training schools and equipment; grant money for starter sets of bees for graduates of short-course programs; revolving small-loan funds to allow expansion of numbers of hives and auxilliary equipment; grant money for development of processing, packaging, and marketing equipment; and a short-term TDY market study. A special need may be the provision of mobile equipment to assist with extraction and marketing of the honey produced.

ECONOMIC AND SOCIAL EVALUATIONS OF PROPOSED INTERVENTIONS

An evaluation of the economic and social consequences of proposed interventions should be an integral part of development programs. From the economic standpoint, programs and specific interventions must offer promise for satisfactory monetary returns, both to the families involved and to the agencies which provide development capital. From the social standpoint, assurance must be given that adjustments are in accord with prevailing cultural and social conditions and that the rewards, both financial and non-monetary, accrue to those for whom the programs are designed. Both aspects will be assessed in the following sections.

Economic Evaluations

An economic evaluation of alternative model-farming systems and of the economic impact of various project proposals is not possible without properly structured data on physical inputs and outputs, capital investments required, and cost/return information. The general procedure for economic analysis is in accord with the step-by-step process outlined in Appendix A.

The first step in the procedure is to assemble available data on the physical resources and their current use. Earlier sections of this report summarize the soil and water resources, the climatic factors, and other basic resources. Since rainfall is limited and erratic, the productivity of land resources

depends greatly upon irrigation water and facilities for its application. Appendix tables 14, 15, and 16 provide information on the current status of irrigation water use and available equipment.

In the dryland areas of Central Tunisia, the only grain crops produced, of any consequence, are durum wheat, bread wheat, and barley. Available data on production of these cereal crops in the project area are summarized in Appendix tables 4, 5, and 6. Wheat is not well adapted in the dryland areas and yields are very uncertain because of undependable rainfall. Barley yields are more reliable but, according to research under semi-arid conditions, more productive varieties could be adapted to the area.

Harvested forage in the project area is confined largely to irrigated areas, both on public and private lands. Data for such production were not available in all delegations. Appendix table 7 summarizes production of alfalfa, maize, vetch/oats, sorghum, and barley, used as forage, on public lands in Sbiba and Sbeitla delegations. Appendix table 8 includes data for these forage crops on private lands in several delegations.

Vegetable crops provide the highest income use of irrigated lands. Statistics are not available for the areas of commercial vegetables irrigated in all delegations. However, Appendix table 9 includes a summary of the hectares of major vegetable crops produced under irrigation in Sbiba and Sbeitla

delegations in 1977. Similar data are included in Appendix table 10 for irrigated vegetables grown on private lands in several delegations in the area in 1977.

While commercial vegetables and fruit production seem to offer greatest promise for increasing family income on the small irrigated farms, careful attention must be given to potential marketing problems associated with substantial increases in production. At present, special "Market Days" are scheduled at major towns throughout the project area each week to provide an outlet for fresh vegetables and other products. Local buyers are the primary customers but "middlemen" also buy regularly for transport to Tunis, Sfax, and other population centers. As total production of vegetables and fruits accelerates in the area, commercial processing and storage will become essential and new plants will be needed -- such as the one reported to be under construction in Sbiba.

Preparation of Enterprise Budgets

In order to evaluate the economic consequences of different kinds of farming systems which may be adapted to the project area, more specific data on yields, prices, costs, and investments expected for the various crop and livestock enterprises must be collected. Assembling this data in the form of "blocks" or unitary budgets for each separate enterprise -- such as one hectare of barley, tomatoes, or almonds and one breeding unit of sheep -- makes the analytical process much simpler and faster.

Such data as the above were not readily available for the eight different delegations in the project area. However, some information of this kind was assembled by Monia Bouratbine (the CNEA Tunisian counterpart in agricultural economics) for selected irrigated farms in the Djilma delegation of the Sidi Bu-Zid governorate. Similar data were collected by Tahara Ben Salem for some typical enterprises in the five delgations in the Kasserine governorate, both for dryland and irrigated farm units.

In order to organize the available data in form for economic analysis, budget forms were prepared for evaluating crop and livestock enterprises. The forms provide for calculating the gross income for one unit of the enterprise, the associated cash variable costs, and the gross margin. Copies of the forms for various enterprises are included in Appendix Section C. These budgets are included for illustrative purposes primarily as specific data are not available currently for the various crops for conditions which prevail in different delegations and sectors of the project area. However, these preliminary budgets do provide a starting point from which adjustments can be made as more reliable data are gathered in connection with the on-going developments in the project area.

Data were even more difficult to assemble for livestock enterprises prevalent in the area. Sheep and goats, along with some cattle, comprise the productive livestock enterprises. Work animals include donkeys, mules, horses, and camels.

Using the forms previously mentioned, an effort was made to prepare representative budgets for the above enterprises.

Information and assistance were provided by CNEA staff members, Philippe Ardouin-Dumazet and Hafi Chedli, and by Tahara Ben Salem. Copies of these budgets also are included in Appendix Section C.

Specific enterprise data are difficult to acquire in a subsistence-type economy in which much of the production is for family consumption rather than for sale. The sample budgets enclosed with this report can be updated and improved for the area as the rural development program gets under way. Data for doing so may be acquired through enterprise records, case studies, and surveys within the various sectors as the pilot demonstration areas and the individual method and result demonstrations are implemented.

Analysis of Model Farming Systems

In order to evaluate the economic impact of different interventions on individual small farm units, a systematic procedure for analysis is necessary.

In order to proceed with this, a set of evaluation procedures, or worksheets, was prepared for a step-by-step analysis of different kinds of farming systems. These include the following:

TU-1 -- Capital Investment Summary

TU-2 -- Land Use System (Crop Production)

TU-3 -- Livestock System (L.S. Production)

TU-4 -- Economic Profitability Analysis

TU-5 -- Economic Feasibility (cash flow) analysis

TU-6 -- Investment Selection Analysis

The purpose of this set of procedures is to provide a rather quick and simple way to evaluate the economic consequences of making major adjustments in a system of farming. The first step is to classify and itemize the capital investments required -- either for the "present" system or for some alternative one after adjustments are made. Form TU-1 is provided for this purpose.

The second step is to summarize all of the crop production (cereals, pasture, forage, vegetables, fruits, nuts, etc.) expected from the system under consideration. The key figures for analysis are the "gross margin" (Col. 8) and "day's labor" (Col. 10) on Form TU-2. For checking purposes, the total hectares of all crops (Col. 4) also is useful to compare with total hectares in the farm unit. In case of double and multiple cropping, the footnote instructions should be observed.

If any livestock enterprises are included in the farming system -- either "present" or "improved" -- the "gross margin" and "day's labor" for all such enterprises should be computed in Cols. 4 and 6, respectively, on Form TU-3.

The economic evaluation of any system can now proceed by transferring investment, labor, and gross-margin data from the above 3 forms to the referenced lines on Form TU-4. Then, by deducting any "other" cash costs -- those not allocated to the individual enterprise budgets -- the "Net Cash Farm Income" from the farming system can be computed. To arrive at "FARM PROFIT" from the system, two adjustments are needed: 1) a deduction from the net cash farm income for any depreciation allowances

for equipment and buildings and (2) the addition of the "estimated cash value" for all farm-produced food consumed by the family.

The farm-profit figure represents the residual returns to "pay" for operator and family labor, for management, and for interest on investment capital (Line 1 of Form TU-4). An economic return to any one of these resources can be computed by deducting a charge for each of the other two. Lines 20 through 23 of form TU-4 provide a quick method of making these calculations.

Completion of the above analysis may indicate satisfactory returns in the longrun for any particular farming system. However, the system may not be economically feasible (perhaps unworkable) because of cash-flow problems during the developmental, or adjustment, years. Form TU-5 provides a way of checking on the adequacy of the system from the standpoint of cash flow in a typical year, after the plan is in operation. This might be supplemented by several cash-flow budgets during the years of adjustment.

As noted on lines 2, 3 and 4 of Form TU-5, all other cash family income is added to the net cash farm income on Line 1 to compute the "Total Cash Family Income". Then, deductions are made for estimated <u>cash</u> expenses for family living, lines 6 through 11, to arrive at the "Net Cash Family Income" on line 12. The family can then decide if this seems adequate to meet commitments for principal payments on debts, for new investments, and for family savings.

One other type of economic analysis was proposed by Blackton and Dalton. (Blackton and Dalton, 1978, pages 28-31). This was referred to as a "Formula for Investment Selection", considering both productivity and equity.

Since most interventions in agriculture necessitate adjustments in farming systems -- both in the types of enterprises included and in the improved practices and technologies applied -- an adaptation of the above formula was designed to aid in investment selections. This is illustrated in Form TU-6, Calculation of Formula for Investment Selection. As noted, this involves a comparison of the net cash farm income from a "typical farm" as now organized and operated with that of an improved system for the same farm unit. Then, this may be related to the estimated development cost per farm for the intervention under consideration, using the Blackton-Dalton formula.

From a practical standpoint, the actual use of the above procedures in evaluating the economic advisability of implementing any particular intervention, or a combination of several, can be applied with little difficulty.

The first step would be to specify the production program for a "typical farm unit", as now operated, in the area where major interventions are to be implemented. Then, this "present model farming system" would be analyzed with the procedures, TU-1 through TU-6, to determine the economic measures previously discussed.

The next step would be to conceptualize an "improved model farming system" (a combination of enterprises and improved technologies) for the same typical farm unit, after the proposed interventions are assumed to be fully implemented and the "new system" is in operation as planned.

The third step would be to compute the investment-selection formula, using the change in net cash farm income generated by the improved system. The resultant value then could be compared with the economic and equity impact of various other intervention combinations, calculated in a similar manner for the effect on typical farming units in the project area.

This hand-calculated analysis seems quite adequate for the kinds of economic evaluations needed in the Central Tunisia area where the present farming systems are rather primitive, for the most part, and where enterprise choices are few in number. However, for more sophisticated analyses, perhaps at some later stage of development, procedures such as this could be computerized for linear programming and other forms of budgeting and evaluations.

Neither the time nor sufficiently accurate enterprise budgets were available for preparing such evaluations for the Central Tunisia area in connection with this assignment. However, in order to demonstrate the analytical procedure, two completed sets of the evaluation procedures are included in Appendix Section D of this report.

Economic Evaluations of Sample Model Farming Systems

As an example for illustrating the evaluation procedures, a twenty-hectare dryland farm unit is assumed and seems rather typical of many observed and visited during the time spent in the area.

For the "present model farming system," the production of barley, pasture, and sheep are assumed to be the income-producing enterprises.

Interventions conceptualized for the "improved system," include some increase in barley acreage, higher yields and income per hectare with better adapted varieties and the addition of a two-hectare plantation of almonds. The assumption also was made that no irrigation water could be made available but that shallow-well water was adequate for family and livestock needs for both systems.

Enterprise budgets included in Appendix Section C were used as a basis for calculations.

Reference to the sample evalutions in Appendix Section D reveals the consequences of the interventions included in the improved system. The changes may be noted on the following page.

Similar evaluations could be calculated to determine the economic impact of any combination of interventions on the farm family units involved.

Item	Present System (TD)	Improved System (TD)
Net Cash Farm Income	163	325
Farm Profit	400	595
Labor & Mg't. Return	184	373
Return/day of family labor	1.67	1.91
Return to Capital	180	205
% Return to Capital	5.0	5.54
Total Cash Family Income	220	382
Total Cash Family Expense	200	200
Net Cash Family Income	20	182
Investment-Selection Factor	--	8.1C'

Social Evaluation

The discussion in this section will focus on two general questions: (1) Who will benefit from the proposed interventions? and (2) What constraints can one anticipate in trying to implement the interventions? This analysis must, of necessity, be incomplete due to the short amount of time available to develop an understanding of the rural social structure in Central Tunisia and the larger system within which it operates. Richard Fraenkel is performing much the same kind of analysis for the rural development project as a whole and his report will undoubtedly add much in the way of useful specifics to these general comments.

Beneficiary Analysis

Trying to determine with any degree of accuracy who will benefit from an intervention, regardless of its nature and type, is a very risky proposition. All such changes occur within a broad context of status and power relationships and if those in positions of influence choose to sabotage or dilute the proposed changes, the chances are good they will be able to do so. Even the best planned and best intended programs fall victim to this problem. Consequently, the best one can do is to offer suggestions for change which maximize the probability of success, but it must be understood that in no case does the probability of failure reach zero.

The proposals offered earlier can be grouped into two categories, those designed to assist dryland farmers to irrigation potential and those designed to maximize the earning potential of dryland farmers who must remain in a dryland condition. The beneficiary analysis that follows will discuss each of these. However, any understanding of the impact of the proposed interventions on an agrarian society must include some discussion of the land tenure system and the distribution of land ownership. Consequently, this will be the point of departure.

Land distribution and tenure. Data on land distribution, while not available for all of the eight delegations, were

available for the Thala - Sbiba region and the Maktar - Rohia Delegations. In Sbiba, the team was told that 8 percent of the farms were 5 hectares or less (20 percent were thus on more than 5 hectares). By using the amount of usable agricultural land one was able to determine that approximately 80 percent of the farmers were farming 64 percent of the land with 20 percent farming the remaining 36 percent of the land. These would appear to be favorable ratios, particularly when compared with the situation in the northern portion of the country.

In the Thala - Sbiba region as a whole (Zone 1 of the CNEA study for the World Bank), the following figures were cited:

Farm Size	% of Farms	% of Surface
0- 5	35	10
5-20	52	45
20-50	10	23
50+	3	22

In this case the distributions are not quite as favorable as those for Sbiba alone. Part of the reason for this may be the large number of small irrigated plots comprising the Sbiba perimeter. In addition, field observations in the Thala Delegation and discussions with the Thala Delegate indicated the Delegation may have a relatively large proportion of large farms when compared with the rest of the Kasserine Governeriat.

For Maktar - Rohia, 86 percent of the surface area was in farms 20 hectares or less and only 2 percent was in holdings over 100 hectares. Further, 83 percent of the farms were less than 20 hectares and 54 percent were less than 10 hectares.

It should be noted that while large land holdings don't predominate, every sector probably has at least some and the probability is high that the Omdah of the sector is, himself, a large landowner (Fraenkel, 1977a).

Although conclusions on the basis of such spotty data are risky, the data that were available, coupled with firsthand observations and interviews with farmers, would seem to indicate that the region is dominated by small farmers. Most are on less than twenty hectares and many are subsisting on less than five hectares. All other things being equal, programs designed to reach small (and poor) farmers should have no trouble identifying a potential audience.

The land tenure situation in the region is complex, particularly to an outsider. The situation that characterizes the north (farm consolidation and/or renting of land by large farmers from small farmers) does not seem to hold for most of the central region. However, Attia (1974) did observe that in the best cereal land in the Thala Delegations, a system similar to the north, the uprooting of small cultivators, did seem to be occurring. On balance, though, the practice of

renting land is not a common occurrence in Central Tunisia probably because cereal production is such a marginal venture at best.

Although specific data were lacking, the team also observed several instances of absentee ownership where the farm was being run by a manager for a share of the crop or a salary. This is not believed to be a wide-spread phenomenon and all the cases observed were in the Thala Delegation.

Generalizations regarding the registering of land through formal titles are impossible to make. Some delegations, notably Foussana and Sbeitla, have done a great deal in this regard with 50 percent and 60 percent of the land held in private hands now titled. At the opposite pole is Thala - Sbiba. In those two delegations (combined) 98 percent of the land is as yet untitled although rights of private ownership may be established in practice on much of the land. According to a CERES survey, 80 percent of the farmers in the Thala - Sbiba area are requesting individual attribution of all lands, even pastures (Attia, 1974). The discrepancies from delegation to delegation appeared to be due, in large part, to the priorities of the individual delegate. In Foussana, the delegate had made land titling his number-one priority and had made good progress. The same was not true in all delegations.

Two additional comments on the distribution of land seem in order. First, with the exception of forest land, the

state owns very little land in the region. Unlike the north, there are very few state farms or cooperatives in the eight delegations comprising the region. Second, the fractionalization of land holdings is, in some places, extreme. For example, in a survey of 80 farms in Maktar - Rohia, only 25 percent were composed of a single tract and 10 percent were made up of 8 parcels each. The mean number of land parcels per farm unit was 3.5

Irrigation interventions. Given the preponderance of small land holdings in the region and what has apparently occurred in the Sbeitla and Sbiba irrigation perimeters, there is good reason to believe that the proposals recommended above would directly benefit small producers. Not only in the level of technology appropriate to small plots and labor intensive enterprises, but where it is not (e.g., equipping capped deep wells with pumping units), there is some reason to believe that the benefits would accrue to many rather than few.

When the Sbeitla and Sbiba perimeters were completed, rather than simply permitting the benefits of the perimeter to fall to those whose land it resided on, the GOT began a small-scale program of agrarian reform. While this is not complete as yet (even after 20 years), it takes the form of dividing irrigated plots into relatively small units (usually 2-4 hectares) and compensating those owners who have had their plots divided with dryland outside the perimeter.

If the same procedure were followed for similar situations in the Central Tunisia area, the distribution of benefits could be spread rather widely. For example, if a deep well could irrigate 30 hectares, then this could be divided up into 10-15 small plots of 2-3 hectares each. The owner(s) of the large plot would receive only their share(s) and would be compensated with land from the other families benefiting from the water.

In the case of well improvements on small private farms, the outcome would, if anything, increase the viability of that enterprise and make it less vulnerable to outside pressures for farm consolidation.

Some other positive results could also result from the proposed small-scale irrigation projects. First, since irrigated agriculture is a much more labor-intensive enterprise than dryland cereal farming, there may be increased employment opportunities for dryland farmers on the small irrigated plots. There "jobs" admittedly would be both seasonal and temporary, but they would be a source of cash income in an area of chronic underemployment.

Second, the irrigated plots would enable the region to become far less dependent on the government for emergency forage supplies since supplies of local forage would be increased due to the greater productivity of the irrigated plots. This would be of direct benefit to those on the irrigated plots, but it could also help dryland farmers who

produced more than they consumed. Forage production should be strongly encouraged on the irrigated hectareage as it meshes best with the prevailing system of sheep production. In addition, Tunisia does not seem to lack vegetables but it is short of red meat.

Finally, the additional irrigated hectareage could markedly improve the diets of those with access to the water. Even if small kitchen gardens were all that resulted, the availability of fresh vegetables for even part of the year would be of great benefit to diets lacking the nutrients such commodities provide.

Irrigation water can work miracles on the dryland areas when properly utilized. Examples of this abound in the area. By making it available to the greatest extent possible, one could expect dramatic increases in the level of living for those affected. Pressure to leave the land would be be reduced and economic independence would be increased.

Dryland interventions. The proposals for the dryland areas are of two kinds: (1) development of apiculture, arborculture (e.g., almonds), and varieties of cereals and cultural practices appropriate for the Central Tunisian area; and, (2) improve rangeland through controlled grazing and development of new rangeland grasses.

Both of these will involve a combination of research and outreach programs. If successful they will have a wide-spread impact on small dryland farm operators. While it

is likely such things as improved barley and controlled grazing can help this group, it must be recognized that the increment of gain will be small. The Central Tunisia area is not particularly suited for cereal production (although it is better suited for barley than wheat) and the best that can be hoped for here is to make a bad situation slightly better. Likewise, while controlled grazing may slightly increase the carrying capacity of the land, the land holdings are currently so small that the marginal gain for any given farmer will not be great.

It is ironic that, because the land is so marginal and the income potential so poor on the dryland farms (even after the proposed interventions), the likelihood of the land becoming attractive to large-scale commercial operations is very low. Certainly the few large farmers in the region will benefit from these interventions the same as the small. Knowledge cannot be contained within one group indefinitely. However, the potential number of small farmers who could benefit is a very large proportion of the total population of the area.

The methods proposed to disseminate the information accumulated by the various research projects rely on a horizontal, instead of a vertical, communications model. Rather than trying to work totally within the various bureaucracies, the emphasis is on developing approaches which would be widely accessible to a number of farmers. Ideally

these would be operated by a local small farmer trained to follow the suggested practices. Technical assistance would be available from the various agricultural agencies, if required.

Finally, it should be stressed that the new techniques emerging from the various research demonstration efforts should not require a vast array of new technological apparatus. In designing these proposals, the constraints of capital and the recognition of the farmer's ability to risk were the primary building blocks. Increments in production (variable) costs for individual farmers should be small (although it could be argued any increment is too much for most), and additional investment capital requirements should be nil, if the proposed loan/grant programs are approved.

In summary, because of the limited potential of the region, the great preponderance of small farmers and the labor intensive enterprises which characterize the farming systems for which the area is suited (e.g., sheep), there would seem to be a high probability that it will be the small farmer who will benefit from the suggestions made above. However, many obstacles stand in the way of this goal.

Constraints to Implementation: Farmer Characteristics

A general observation made during the field investigations was the dryland farmers who were irrigating small tracts from shallow wells were not making particularly effective use of the available water when compared with the farmer in the irrigated perimeters (who themselves have been criticized for poor production efficiency). Although some of this inefficiency may be due to factors beyond the control of the farmer, some characteristics of the farmers themselves no doubt contribute to the problem.

The transition from a dryland farm operation to an irrigated operation, even if small in size, is a major adjustment on the part of the farm operator and his family. Among other things, the mount of labor required increases dramatically, particularly in the case of vegetable production. Further, the type of work is much more demanding physically (caring for vegetables is much different than caring for sheep). This change is particularly true for the farm operator himself. In a dryland condition, once the wheat or barley has been planted, farm labor requirements for him drop to near zero as the care of animals and weeding of fields seem to fall primarily to the women and children. Although one suspects that all farmers, if given the cnoice, want to irrigate, many may have little idea what this means in terms their lifestyle. Not only do all the jobs that existed

before continue to exist, but a whole new set are added. This change undoubtedly comes as a severe shock to many.

Coupled with this is the whole matter of individual motivation. The worse example of underutilized wells were on those farms where the wells and pump sets had been provided by the GOT as part of a development project. Wells constructed by the owner himself tended to be operated more efficiently. How much of this can be linked to a lack of individual initiative (the CRDA technicians, and even some of the farmers themselves, attributed the problem to laziness) or to other factors, is impossible to say, but the individual component cannot be excluded.

One thing does seem clear. Farmers outside the irrigated perimeters lack good "role models" on which to fashion their irrigated operations. Although they may work extremely hard and might even receive some governmental assistance, the lack of good examples using technology and resources similar to what they have available has to play a major role in the low efficiency rate. This is the reason for the proposal to set up small-scale demonstration plots in as much of the region as possible so farmers could actually see what they ought to be working toward.

The suggestions for changes in dryland farming operations, while less dramatic, are no less problematic. Long standing cultural practices and the lack of resources make change difficult. Appealing in this case though is the

model of change that argues that traditional small farmers will change if given the means and incentive to do so. The recommendations for USAID suggest some ways in which this might be done and they can speak for themselves. Let it suffice here to say these are basically rational people who will do what is best for their own self-interest in the light of a very limited range of alternatives. By broadening that range and providing mechanisms for the farmer to observe the choices available to them, it is the team's belief that change can occur.

The case of controlled grazing is one example. Over-grazing is basically a rational response to a situation of too many people on too little land. In such situations one is not likely to be very future-oriented. The team observed two different approaches to this problem. One, a state farm near Sbeitla simply subdivided a large plot into quarter sections and allowed grazing on each section for three months followed by an idle period of nine months. The second, in the northern part of the country well outside the project area, involved the state taking over the management of contiguous tracts of private land in exchange for improving the pasture. The owners, in return, were assigned grazing rights (on a fee schedule) based on the amount of land they had contributed to the project. After ten years, the latter project has finally reached the point where groups of property owners are requesting state assistance.

Both models seem to offer advantages and disadvantages and how they would work on the small plots that characterize Central Tunisia is an open question. The point is that demonstrations of this sort can serve to change people's behavior, but one has to be prepared for a long-term effort. Centuries of grazing practice are not going to be altered overnight.

Constraints to Implementation: Institutional Factors

This section will necessarily be brief because it was not possible to do an elaborate institutional analysis in the time available. However, some potential problems did emerge in the course of the fieldwork and review of literature.

Credit structure. The one institution which everyone seems to agree does not serve the needs of small farmers is the credit structure (see Fraenkel, 1977b, 1977c and CNEA, n.d.). The CNEA study noted that although the Local Mutual Loan Banks (CLCM) were set up specifically to help small farmers, the ratio or recipients to number of members has been steadily decreasing and a privileged clientele group has emerged. This has happened at the same time that the amount of money actually loaned has been increasing. The report concluded by saying the interests of the medium-sized farmer were being served at the expense of the small operators.

Further complicating this is the difficulty encountered in trying to implement a credit program designed exclusively for small farmers. In his analysis of the SIDA project which was set up to help farmers with five hectares or less, Fraenkel noted that this goal was in conflict with the interests of the large landowners in the region. As a result, a number of obstacles were set up by the sector Omdahs (themselves large farmers) and the program goals were never achieved.

Whether the general observation made by Fraenkel in his analysis of the Omdah (an intermediary function placed in the hands of a large farmer, whose interests are in conflict with policies promoting increased access of small farmers to the institutional structure, is sufficient to make institutional change difficult at best) is applicable to Central Tunisia is a debatable point. It probably does not hold to the same degree it does in the north as the land-man relationships are quite different. However, to the degree it holds at all, it will make institutional change problematic.

Nevertheless, it does seem clear the prevailing credit structure is not capable of serving the needs of small farmers in the area and a structure similar to the small farmer credit program for the five northern governeriats will be needed in Central Tunisia as well.

Extension services. The second major institutional constraint concerns the ability of the various governmental organizations concerned with agriculture to design programs to reach small farmers. Fraenkel (1977a) has observed that contemporary Tunisian agriculture is characterized by great dependence on public institutions and access to those institutions is in direct relationship to one's position in the status-power hierarchy.

Although the GOT has taken a number of steps to decentralize its decision-making functions, the local bureaucracy still remains quite complex. Control of some policies, such as prices of certain commodities, remains a prerogative of the central government in Tunis and certain of those pricing policies run counter to the proposals offered earlier. Even for locally-made decisions, it is still necessary for an individual farmer to visit a number of offices to obtain all the necessary signatures.

Another major problem is how to induce qualified agricultural specialists to live and work in the region. Nearly every office visited reported a number of openings which apparently are nearly impossible to fill. Compounding this problem is the apparent inability of the technicians, once there, to move from the office to the field. Whether this is due to personal inclinations or bureaucratic demands on their time, the result is the same. Attia (1974) noted in a survey of farmers in one delegation of the area, that 70 percent had never had contact with an engineer and

51 percent had never had contact with a "sub-engineer." Even worse, only about 45 percent of those who had had contact with either felt the contact was useful. The implications here seem obvious: There need to be more, better trained technicians whose primary responsibility is field work.

One observation seemed to characterize most of the interviews with officials in the area. Projects with concrete results such as bridges, roads and water diversions are looked on with favor while those with less tangible goals (e.g., dissemination of information) seem to receive lower priority. This situation will have to be considered if the proposals offered are to have any chance to succeed.

After viewing the two state-run range management programs and talking with Dr. Novikoff (Tunisian Presaharian Project), it was the team's belief that any range management intervention adopted ought to include participation by those most affected. Given the suspicion of much of the Tunisian peasantry to the involvement of the GOT in agriculture (traceable to the agricultural collectivization program of the 1960's, now abandoned), the likelihood of a program being accepted within a relatively short period of time will be enhanced if the programs involve local people. It is the team's belief that the heterogeniety of the area makes locally planned programs a must. While certain general guidelines can be used to structure project planning, implementation is probably best left to those who are

familiar with local conditions. The input of local people, and in particular local small farmers, ought to be not only accepted but actively sought.

Market structure. Tunisia has a well developed system of local markets which occur on a weekly basis in many communities throughout the region. Of particular concern here though is the ability of the local marketing system to absorb much in the way of additional land to be brought under irrigation. For this reason, a careful analysis of the capacity of the market systems ought to be undertaken before farmers are encouraged to grow vegetables as opposed to small grains or forage. The proposed construction of a vegetable processing plant in the region could also have a significant effect on the current situation.

The pricing structure of agricultural commodities is also in need of further analysis. Some have argued (Castelli-Gattinara, 1976) that the low productivity within the irrigated perimeters is due to the low labor returns for the vegetable crops produced. In suggesting cropping systems for the acreage to be effected by the interventions proposed earlier, attention should be given to this situation.

Conclusion

It seems clear that what is needed is an integrated approach to the agricultural production problems of the region. It will do little good to provide new irrigation

equipment if there is no instruction on how best to use it. Nor does it do much good to provide instruction if one can't obtain credit to buy a pump. Simultaneous efforts on the individual and institutional fronts will be necessary for any program to succeed.

The issue of out-migration from rural areas was raised by a number of GOT officials at both the local and National level. It is undoubtedly a major source of concern to them and the team was asked specifically to address the issue. The answer though is not a simple one.

For those farms which are able to irrigate there is a good chance that, with increased levels of well being, the rate of out-migration will be reduced. However the same cannot be said for the dryland areas. The proposed interventions while of some help, will not solve the acute problems of the dryland farmer. The small land holdings which already exist, and the likelihood of increased fractionalization as subsequent generations take their share, has created a situation where there are simply too many people trying to survive in too small an area. The GOT should give serious consideration to a policy which would encourage selective out-migration, particularly from the dryland areas, by providing off-farm employment opportunities in the population centers of the region. This might permit land holdings to expand to a size sufficient to allow incomes to begin to

approach the Tunisian national average. A policy of encouraging people to remain on the dryland areas in large numbers is probably doomed to failure unless extremely coercive measures are used to implement it.

The problem of further land fragmentation in Central Tunisia, whether it is on irrigated land or dryland, is a major policy issue for the GOT. Yet it is not one which anyone seems anxious to address. It seems currently to be treated as a legal, rather than a policy matter which, within a few generations, could prove disastrous. The continual subdividing of marginal lands has already created a bleak life for many people and the situation for the next generation will only be worse unless things can be turned around. The recommendation here is not to make all farms large. Rather one should be working toward farm units which are of a size capable of providing a family with a decent income. On a land with water that might be 2-4 ha, on dry land it might be 50 ha. Strict adherence to definitions of "small", without taking into account the resource base, ought to be discouraged by agencies at all levels. Simply put, measures of size according to amount of hectorage are not only incorrect but dangerously misleading from a standpoint of policy making.

One final comment concerning the role of women also needs to be made particularly on how all of this may affect them. Because of their protected lives the role of women

in agriculture in Tunisia is not well understood, particularly by a group of Western males. It does seem clear, however, that it is significant. The transition from dryland to irrigated operation will undoubtedly lessen the water carrying burden for those women affected, but it also seems likely that they will be the ones doing much of the "stoop labor" in the small irrigated plots. On the dryland areas their roles will probably not change markedly. They will still carry the burdens of hauling water and collecting weeds for livestock feed and fuel for cooking. While not reducing their workload it would seem that the interventions would not add greatly to it.

The role of women in rural Tunisian society is obviously only one area where little is known. Other examples abound, for example, the process of communication flow (e.g. sources of legitimation) is not known nor the kinds of pilot projects which have the greatest chance for success. Research on areas such as this should be undertaken during the course of the pilot projects so that when they are repeated in other regions the best strategies can be used. Implicit in this is an endorsement of the notion of trying a number of approaches initially with a view toward eliminating the ineffective ones over a period of time.

The project should include, from the very beginning, a systematic evaluation component. If properly done, an evaluation research effort can provide a mechanism for making

modifications in program plans and eliminating components of programs that are ineffective. A number of U.S. universities offer training in program evaluation either leading to a degree or of the "short course" variety for those with basic research skills.

Overall, there is some reason for guarded optimism that the lives of some of the areas residents (10-20% perhaps) can be markedly improved as a result of the proposed interventions. The remainder of the population (75-80%) can be helped, but the increment of assistance will be substantially smaller. Nevertheless, it is time to stop doing reports and making recommendations. The people of the region have seen enough of that. The time has come to try <u>something</u> even if the information is not as complete as one would like.

PRELIMINARY COST ESTIMATES FOR PROPOSED USAID INTERVENTIONS

The following cost estimates are suggested in order to implement the proposed interventions for development of the agricultural sector in Central Tunisia.

Project	Amount Recommended ($1,000)
Demonstration Projects using improved irrigation, cereal cultivation, arborculture and apiculture in each of the sectors in the Central Tunisia project area	800
Small Pump Sets for making fuller use of shallow wells	800*
Equipment to pump from previously drilled deep wells not currently developed and used (28 units @$35,720)	1,000
Develop Irrigation Perimeters around deep wells	1,000
Shallow well improvement equipment	300
Land Leveling and Conservation construction equipment for pilot demonstration areas	350

*The following is an estimate of the number of wells in each delegation which are undeveloped and the type of pump system required:

Delegation	Diesel-Centrifugal @ $1,590	Electric @ $1,200	Diesel-Turbine @ $3,600
Jedliane	30	20	--
Foussana	130	20	--
Makhtar	20	--	--
Rohia	20	--	--
Jilma	--	--	--
Sbiba	25	10	10
Thala	60	10	40
Sbeitla	30	10	10
	315	70	60
COST	$500,000	$85,000	$215,000

Project (Cont'd)	Amount Recommended ($1,000)
Grant programs to encourage Arborculture, Apiculture, cereals and rangeland improvement and other inputs to help motivate small farmers to try new practices	500
Human and Animal Needs Well Program	1,000
Revolving loan programs to provide investment capital for small farmers who have little basis for credit	1,500
Facilities and Equipment for implementing and expanded adaptive research programs at Le Kef and Ousselitia Research Centers and extending application research through all delegations of the project area:	
1. Soil Fertility and Available Nutrient testing laboratory equipment	50
2. Establishing and equipping test plots in soil fertility, range management and barley breeding	350
3. Seed Germination laboratory equipment	10
Long-Term AID Technical and Scientific Personnel to work with Tunisian counter parts in expanding adaptive research throughout the project area:	
1. Soil fertility Specialist (24 MM)	180
2. Range Management Specialist (24 MM)	180
3. Agricultural Production Economics Specialist (24MM)	180
4. Rural Sociologist (24 MM)	180
5. Agricultural Engineer (Specialist in soil and Water Conservation) (24 MM)	180
Short-Term (TDY) technical assistance in erosion control, water management, apiculture, farm management, rural sociology and other specialities for initiating special projects and training programs (20 MM @ 6,000)	120
Support for training Tunisian students at U.S. universities:	
1. M.S. Graduate training in Soil Fertility	30
2. M.S. Graduate training in range management	30
3. M.S. Graduate training in soil and water conservation	30
4. M.S. Graduate training in rural sociology (3 yrs.)	42
5. M.S. Graduate training in farm management	30

Project (Cont'd)	Amount Recommended ($1,000)
6. Short-term training in Program Evaluation Techniques and research methods (10 MM)	21
7. Short-term training in Production Economic and Farm Analysis techniques (10 MM)	21
8. Short-term training in Soil and Water conservation techniques (10 MM)	21

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Appendix Section A

PROPOSED ANALYTICAL FRAMEWORK FOR PLANNING, IMPLEMENTING AND EVALUATING PROGRAMS AND PROJECTS

Some systematic and logical procedure for planning, implementing and evaluating programs and projects is considered essential for formulating proposals and carrying them out over time. The following ten-step process is suggested.

1. INVENTORY RESOURCES—Classify and evaluate the different kinds of resources on which the longrun agricultural development of the country depends.

2. ESTABLISH GOALS—Conceptualize and articulate the goals to be achieved through the plans and programs developed.

3. IDENTIFY PROBLEMS—Itemize major constraints which hinder attainment of goals.

4. ANALYZE ALTERNATIVES—Evaluate the pros and cons of different strategies for development.

5. CHOOSE A PLAN—Select a strategy for development which seems most appropriate for the resources available, for the current situation and stage of development, and for the planning horizon considered.

6. TAKE ACTION—Outline the most relevant actions, the programs and projects, which will help implement the chosen strategy in the most expeditious and effective manner possible.

7. ALLOCATE RESPONSIBILITIES—Assign responsibilities, along with authority for execution of plans, to those who will carry out various phases of programs and projects.

8. EVALUATE PROGRESS—Establish benchmarks as a basis for measurements and devise a continuing system of records, reports, and analytical procedures to aid in evaluating progress over time.

9. ESTABLISH CONTROLS—Set up administrative policies, procedures, and accounts to help assure the use of capital and other resources in accordance with development plans selected.

10. ADJUST—Incorporate sufficient flexibility in programs and projects to facilitate adjustments in case of unexpected events which either retard progress or hasten development.

APPENDIX SECTION B

Reference Tables of Statistical Data

Appendix Table 1. Population by Delegations in the Central Tunisia Rural Development Project Area 1975 Data.

Delegation	Number of Sectors	Population		
		Total	Men	Women
Sbeitla	11	38.041	19.472	18.569
Sbiba	7	21.292	10.502	10.790
Jedliane	10	21,076	10,434	10,642
Thala	16	40.543	19,945	20.598
Foussana	9	34.365	17,029	17.335
Makhtar	12	39.191	19.668	19.523
Rohia	6	16,201	8.025	8.176
Djilma	9	27,704	13.665	14,039

Source: Recensement général de la pópulation et des logement du 8 Mai 1975.

Institut national de la statistique.

Appendix Table 2. Gouvernorats, Delegations, and Secteurs included in the Central Tunisia Rural Development Project Areas.

Gouvernorat	Délégations	N°	Secteurs
Kasserine	Thala	1	Aïn Jdida
		2	Lajred
		3	Barmajna
		4	Boulahnach
		5	Haïdra
		6	Chefaï
		7	Hmad
		8	Ouljet Edhol
		9	Dachra
		10	Joua
		11	Thala Est
		12	Thala Ouest
		13	Tbaga
		14	Mkimen
		15	Oued Racheh
		16	Zelfane
	Foussana	1	Afrane
		2	Bouderiass
		3	El Hazza
		4	Foussana
		5	Adhira
		6	El Brika
		7	Khmouda
		8	El Mzirâa
		9	Ouled Mahfoudh
	Jedliane	1	Aïn El Hmadna
		2	Aïn Oum Jdour
		3	El Bouajer
		4	El Brika
		5	El Hmaïma
		6	El Grine
		7	Jedliane
		8	Remada
		9	Terbah
		10	Tiouacha

Table 2. (Continued)

Gouvernorat	Délégations	N°	Secteurs
Kasserine	Sbiba	1	El Ahouaz
		2	Aïn Zaïane
		3	Aïn Khamaïsia
		4	Brahim Zahar
		5	Oued Lahtab
		6	Sbiba
		7	Thmad
	Sbeïtla	1	El Athar
		2	Echrayaa
		3	Edoubab
		4	Garâa El Hamra
		5	Erakhmat
		6	El Gounna
		7	El khadra
		8	Machrek Echamss
		9	El Mzarâa
		10	El Oussaïa
		11	Semama
Sidi Bou-Zid	Djilma	1	El Amra
		2	Salta
		3	Djilma
		4	Labaïedh
		5	Baten El Ghazel
		6	Guhedir Ezzitouna
		7	M'ghila
		8	Sabbala
		9	Essed
Siliana	Makthar	1	Beze
		2	Garaa
		3	Beni Hazem
		4	Ras El Oued
		5	Saddine
		6	Sayar
		7	Kessera
		8	Mansoura
		9	Gueria
		10	Fdoul
		11	Ellouza
		12	Essouralem

Table 2. (Continued)

Gouvernorat	Délégations		Secteurs
Siliana	Rohia	1	Msahla
		2	Smirat
		3	Haria
		4	Rouhia
		5	Jmilet
		6	Hababsa

Appendix Table 3. Yields of Irrigated Crops in the Central Tunisia Project Area

Crops	Private Land		Public Land	
	Actual Yield (q/ha)	Yield Forecast (q/ha)	Actual Yield (q/ha)	Yield Forecast (q/ha)
1. VEGETABLES:				
Tomatoes	10	20	13	20
Peppers	6	10	6	9
Potatoes (out-season)	7	13	9	13
Potatoes (in-season)	6	10	8	10
Melons	20	30	23	30
Onions	15	20	20	20
Carrots	8	8	20	20
Turnips	20	25	25	25
Broad Beans	8	8	25	25
2. FORAGES:				
Alfalfa	30	40	37	40
Maize	10	15	10	15
Vetch/Oats	3	5	4	5
Sorghum	22	25	22	25
Barley	15	25	15	25

Source: Commisseriat regional de développement agricole (CRDA), Tunisia.

Appendix Table 4. Area, Yield, and Production of Durum Wheat in Dryland Areas of Central Tunisia, 1977.

Crops	Durum Wheat			
Delegations	Forecast (ha.)	Actual (ha.)	Yield (q/ha.)	Production (q)
Thala	16,060	20,500	2.2	45,100
Sbiba	10,150	9,900	1	9,900
Jedliane	15,030	16,000	2.2	35,200
Sbeitla	8,020	13,000	1	13,000
Foussana	7,010	7,530	1	7,530
Rohia & Makthar	28,000	30,660	5.6	176,700
Djilma	—	5,000	3	15,000

Source: CRDA, Tunisia.

Appendix Table 5. Area, Yield and Production of Soft (Bread) Wheat in Dryland Areas of Central Tunisia, 1977.

Crops	Soft Wheat			
Delegations	Forecast (ha.)	Actual (ha.)	Yield (q/ha.)	Production (q)
Thala	6,140	2,200	1	2,200
Sbiba	1,580	1,600	1	1,600
Jedliane	1,520	1,400	1	1,400
Sbeitla	1,020	700	0.9	600
Foussana	500	400	1	400
Rohia & Makthar	6,700	5,460	5.6	30,575
Djilma	—	—	—	—

Source: CRDA Tunisia.

App. Table 6 Area, Yield, and Production of Barley in Dryland Areas of Central Tunisia, 1977

Crops	Barley			
Delegations	Forecast (ha.)	Actual (ha.)	Yield (q/ha.)	Production (q)
Thala	10,000	13,000	1.8	24,000
Sbiba	8,000	7,000	0.5	3,500
Jedliane	3,000	5,000	2	10,000
Sbeitla	7,000	7,000	0.5	3,500
Foussana	6,000	6,500	0.5	3,250
Rohia & Makthar	5,000	6,540	5.8	37,930
Djilma	--	10,000	4	40,000

Source: CRDA, Tunisia.

App. Table 7 Area of Irrigated Forage Crops in 1977 on Public Lands in Two Delegations of the Central Tunisia Project Area

Forage Crop	Hectares by Delegations	
	Sbiba	Sbeitla
Alfalfa	100	12
Maize	23	5
Vetch/Oats	140	9
Sorghum	11	2
Barley	250	12
TOTAL	524	40

Source: CRDA, Tunisia

App. Table 8 Area of Irrigated Forage Crops in 1977 on Private Lands in Five Delegations of the Central Tunisia Project Area

Forage Crop	Hectares by Delegations				
	Thala	Sbiba	Jedliane	Sbeitla	Foussana
Alfalfa	45	12	3	2	5
Maize	10	6	--	1	25
Vetch/Oats	22	--	--	--	--
Sorghum	17	--	--	--	--
Barley	30	80	--	1	45
TOTAL	124	98	3	4	75

Source: CRDA, Tunisia

App. Table 9 Area of Vegetable Crops Irrigated in 1977 on Public Lands in Two Delegations of the Central Tunisia Project Area

Vegetable	Hectares by Delegations	
	Sbiba	Sbeitla
Tomatoes	215	12
Peppers	90	11
Potatoes (summer)	7	4
Potatoes (winter)	10	5
Melons	40	15
Onions (summer)	70	8
Onions (winter)	25	9
Broad beans	90	8
Carrots	30	8
Turnips	40	7
TOTAL	617	87

Source: CRDA, Tunisia.

App. Table 10 Area of Vegetable Crops Irrigated in 1977 on Private Lands in Five Delegations of the Central Tunisia Project Area

Vegetable Crop	Hectares by Delegations				
	Thala	Sbiba	Jedliane	Sbeitla	Foussana
Tomatoes	40	90	2.0	6	20
Peppers	60	85	4.0	6	30
Potatoes (summer)	6	8	.5	--	3
Potatoes (winter)	--	10	---	--	--
Melons	22	25	2.5	4	20
Onions (summer)	12	25	3.0	2	15
Onions (winter)	38	35	1.5	1	16
Broad beans	25	120	8.0	1	15
Carrots	31	20	3.0	1	20
Turnips	25	15	4.0	2	15
TOTAL	259	433	28.5	23	154

Source: CRDA, Tunisia.

App. Table 11 Breakdown of Livestock Numbers by Delegations in the Central Tunisia Project Area, 1977 Data

Delegations	Cattle		Sheep		Goats	
	mature animals	young animals	mature animals	young animals	mature animals	young animals
Thala	2,700	2,000	17,715	30,960	3,430	8,000
Sbiba	675	500	8,445	14,760	430	1,000
Jedliane	675	500	11,330	19,800	1,850	4,320
Sbeitla	446	330	12,360	21,600	2,140	5,000
Foussana	1,066	790	12,050	21,060	1,540	3,670

Source: CRDA, Tunisia.

App. Table 12 Numbers of Cattle, Sheep and Goats and 1977 Sales by Delegations in the Central Tunisia Project Area

Delegations	Cattle		Sheep		Goats	
	Total Number	Number of Calves Sold	Total Number	Number of Lambs Sold	Total Number	Number of Kids Sold
Thala	4,800	1,200	50,000	22,290	12,000	6,000
Sbiba	1,200	720	24,000	10,625	1,500	750
Jedliane	1,200	720	32,000	14,250	6,500	3,240
Sbeitla	800	480	35,000	15,550	7,500	3,750
Foussana	1,900	1,140	34,000	15,160	5,500	2,750
Rohia	2,640	--	22,000	--	5,300	--
Makthar	5,670	--	43,000	--	31,000	--

Source: CRDA, Tunisia.

App. Table 13 Numbers of Camels, Horses and Mules in the Central Tunisia Area, 1977.

Delegations	Camels	Horses	Mules
	Total Number	Total Number	Total Number
Thala	109	2,706	688
Sbiba	152	170	32
Jedliane	257	235	60
Sbeitla	1,418	197	114
Foussana	370	475	50
Rohia	980	3,530*	
Makthar		7,780*	

Source: CRDA, Tunisia.

*figure denotes horses and mules combined.

App. Table 14 Irrigation from Wells by Delegations in the Central Tunisia Project Area

Delegations	No. Wells	Areas Irrigated in Hectares			
		Actual		Forecast	
		Winter	Summer	Winter	Summer
Sbiba	16	330	270	400	350
Jedliane	54	23	14	60	25
Thala	470	250	200	500	300
Foussana	200	130	135	280	150
Sbeitla	90	13	20	13	20
Djilma*	--	--	--	--	--
Rohia	86	122		260	
Makthar*	--	--	--	--	--

Source: CRDA, Tunisia.
*Data not available

App. Table 15 Irrigation from Dams and Borings by Delegations in the Central Tunisia Project Area

Delegation	Irrigated Areas in Hectares			
	Actual		Forecast	
	Winter	Summer	Winter	Summer
Sbiba	1,300	600	1,667	600
Jedliane*	--	--	--	--
Thala*	--	--	--	--
Foussana*	--	--	--	--
Sbeitla	90	75	160	100
Ojilma*	--	--	--	--
Rohia*	--	--	--	--
Makthar*	--	--	--	--

Source: CRDA, Tanisia.

*Data not available

App. Table 16 Irrigated Areas by Delegations in the Central Tunisia Project Area, 1977

Delegations	Total Area (Ha.)			Area Irrigated in Summer (Ha.)			
				Private land		Public land	
	Private	Public	State	Area	% of total area	Area	% of total area
Foussana	280	--	--	130	46	--	--
Sbeitla	50	160	70*	13	26	90	56
Sbiba	500	--	--	200	40	--	--
Jedliane	400	1,667	--	330	82	1,300	77
Makthar	60	--	--	23	38	--	--
Rohia**	--	--	--	--	--	--	--
Djilma**	--	--	--	--	--	--	--
Thala**	--	--	--	--	--	--	--

Source: CRDA, Tunisia.

* All of State Land irrigated in summer only.
**Data not available.

App. Table 17 Factual Data for Work Animals Used in the Central Tunisia Project Area*

Item	Kind of Work Animal			
	Donkeys	Mules	Horses	Camels
PHYSICAL & ECONOMIC DATA: AVERAGE				
Wt./head (kg.)	100	320	300	350
Selling Price/head	DT 25	DT 200	DT 150	DT 250
Load Wt. On Back (kg.)	50	--	--	150
Load Wt. Drawbar (kg.)	250	400	350	--
FEED REQUIRED/HEAD:				
Barley (kg.)	150	500	500	250
Hay (kg.)	--	1,500	1,500	--
USE OF TIME:				
Traveling %	20-25	20-25	20-25	--
Threshing %	8-10	25	25	--
Transporting %	50	25	20	--
Resting %	15	25	30	--

*Survey Data from CNEA (Philippe Ardouin-Dumazet). Preliminary unpublished information from a graduate student M.S. Thesis to be completed in 1978.

Appendix Table 18 UMC Team Visits in the Central Tunisia Project Area
(one to four team members)
March 6 to March 23, 1978

Delegations	Secteurs Visited
Jedliane (8 of 10)	El Brik
	Tioucha
	Remada
	Ain Oum Jdour
	El Hmaima
	Jedliane
	Ain El Hmadna
	Terbah
Foussana (7 of 9)	El Brika
	Khmouda
	Foussana
	El Mziraa
	Ouled Mahfoudh
	Adhira
	Bouderiass
Sbeitla (8 of 12)	El Ouassaia
	Ech Rayaa
	El Athar
	El Khadhira
	Machrek Echamess
	Edoulab
	Semamma
	El Gounna
Thala (8 of 16)	Zelfane
	Thmad
	Joua
	Thala Ouest
	Chefai
	Dachra
	Barmajna
	Ain Jdida
Sbiba (3 of 7)	Ain Khaissia
	El Ahouez
	Sbiba
Djilma (7 of 9)	Es Sod
	Jilma
	Mghilla
	Selta
	Batem El Ghazel
	El Abiadh
	Sabalet Askar

Appendix Table 18 (Cont'd)

Delegations	Secteurs Visited
Rohia (4 of 6)	Rohia
	Skarna
	El Haria
	Jmilet
Makthar (6 of 13)	Goualen
	Makhtar
	Sayar
	El Garia
	Kessera
	Mansoura
Kasserine (5)	Oued Eddarb
	Doghra
	Kasserine
	Bouzgame
	Sidi Harrath

App. Table 19 Rainfall Data

Stations	Average Annual Rainfall (mm)	Fall Rainfall (mm)	Spring Rainfall (mm)	Rainfall Reached At Least 9 Years Out of 10 (mm)
Kasserine Chambi	350	100	80	200
Foussana	300	110	120	200
Thala	400	120	140	300
Sbiba	350	98	100	200
Rohia	350	100	100	200
Sbeitla	310	100	90	180
Djilma	268	85	90	180

Source: CNEA, Tunisia.

APPENDIX SECTION C

SAMPLE BUDGETS FOR CROP AND LIVESTOCK ENTERPRISES FOR THE PROJECT AREA

FAO Data from Djilma Delegation

CRDA Data for Project Area

*Budget No. 1 - Crop Enterprise Budget - BARLEY

Central Tunisia Area: Delegation Djilma Sector _____

Kind of Crop Barley Dryland ( ); Irrigated (x) (Gravity)

Description Harvested for grain

1.	Yield: ton per hectare.	D	2.0
2.	Price, Dinars per ton	D	44.6
3.	GROSS INCOME per hectare	D	89.2
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	_____
6.	Fertilizer & Lime. (Nitrogen 1q x 5.0) (Phosphate 1q x 3.6)		8.6
7.	Seed . . 1Q		_____
8.	Crop Chemicals & Supplies		_____
9.	Custom machine hire. . . 10.5 x 1.9		20.0
10.	Machinery: fuel, repairs, etc.		_____
11.	Feed & Supplies for draft animals.		_____
12.	Miscellaneous Costs.		_____
13.	Other. Water - 2,000 M3 x 4mm		8.0
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	36.6
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	52.6
16.	Days Man Labor needed/ha 24 x 2.04		48.96
17.	Hours draft animals work/ha. 34 hours		_____

*FAO yields & inputs from Djilma Delegation; price data from CNEA.
(Budget prepared by Monia Bouratbine, CNEA.)

*Budget No. 2 - Crop Enterprise Budget - BREAD WHEAT

Central Tunisia Area: Delegation Djilma Sector _____

Kind of Crop Bread Wheat Dryland ( ); Irrigated (XX) (Gravity)

Description Harvested for grain

1.	Yield: Tons per hectare.	D	2.5
2.	Price, Dinars per Ton	D	58.6
3.	GROSS INCOME per hectare	D	146.5
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	_____
6.	Fertilizer & Lime. (Nitrogen 2 x 5) (Phosphate 1.5 x 3.6)		13.4
7.	Seed (Saved own seed) 1 Q		_____
8.	Crop Chemicals & Supplies		_____
9.	Custom machine hire. 111 hours x 1.9 D		20.9
10.	Machinery: fuel, repairs, etc.		_____
11.	Feed & Supplies for draft animals.		_____
12.	Miscellaneous Costs.		_____
13.	Other. Water 1,500 M3 x 4mm		6.0
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	42.3
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	104.2
16.	Days Man Labor needed/ha . . . . . 24 x 2.04		48.9
17.	Hours draft animals work/ha. 34 hours		_____

*FAO yields & inputs from Djilma Delegation; price data from CNEA.
(Budget prepared by Monia Bouratbine, CNEA.)

*Budget No. 3 - Crop Enterprise Budget - DURUM WHEAT

Central Tunisia Area: Delegation Djilma Sector _____

Kind of Crop Durum Wheat Dryland ( ); Irrigated (XX) (Gravity)

Description Harvested for grain

1.	Yield: Ton per hectare	D	2.0
2.	Price, Dinars per Ton	D	64.2
3.	GROSS INCOME per hectare	D	128.4
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	
6.	Fertilizer & Lime. (Nitrogen 1.5q x 5) (Phosphate 1.0q x 3.6)		11.1
7.	Seed . 1Q. . (Own seed)		
8.	Crop Chemicals & Supplies		
9.	Custom machine hire. 10.5 hours x 1.9		20.0
10.	Machinery: fuel, repairs, etc.		
11.	Feed & Supplies for draft animals.		
12.	Miscellaneous Costs.		
13.	Other. Water - 2,000 M3 x 4mm		8.0
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	39.1
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	89.3
16.	Days Man Labor needed/ha 24.x.2,04		48.96
17.	Hours draft animals work/ha. . . . . 34 hours		

*FAO yields & inputs from Djilma Delegation; price data from CNEA.
(Budget prepared by Monia Bouratbine, CNEA.)

*Budget No. 4 - Crop Enterprise Budget - OATS/VETCH HAY

Central Tunisia Area: Delegation Djilma Sector _____

Kind of Crop Oats/Vetch Hay Dryland ( ); Irrigated (XX)

Description Grown on irrigated land; excellent management

1.	Yield: 40 bales (1320k) per hectare	D	1,320kg
2.	Price, Dinars per kilo	D	40
3.	GROSS INCOME per hectare hay	D	211.2
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	12
6.	Fertilizer & Lime. Nitrogen, Phosphate, Potash (m)		24
7.	Seed		16
8.	Crop Chemicals & Supplies		
9.	Custom machine hire. Harvesting		13 to 15
10.	Machinery: fuel, repairs, etc.		
11.	Feed & Supplies for draft animals.		
12.	Miscellaneous Costs. Manure		5
13.	Other. Water		10
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	82
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	129.2
16.	Days Man Labor needed/ha		
17.	Hours draft animals work/ha.		

*FAO yields & inputs from Djilma Delegation; price data from CNEA.
(Budget prepared by Monia Bouratbine, CNEA.)

*Budget No. 5 - Vegetable Enterprise Budget - CARROTS

Central Tunisia Area: Delegation Djilma Sector _____

Kind of Crop Carrots Dryland ( ); Irrigated (X)

Description _____

1.	Yield: Tons per hectare	D	15
2.	Price, Dinars per Ton	D	2.2
3.	GROSS INCOME per hectare	D	33.0
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs Manure 10 t x 5	D	50.0
6.	Fertilizer & Lime. Phosphate 2.5 q x 3.6 Potash 1 x 7.6		16.7
7.	Seed 2.5 Kg. x		
8.	Crop Chemicals & Supplies Altrax 40 Kg. x 0.23		9.2
9.	Custom machine hire. 12 hours x 1.9		23.1
10.	Machinery: fuel, repairs, etc.		
11.	Feed & Supplies for draft animals.		
12.	Miscellaneous Costs.		
13.	Other. Water - 2,300 M3 x 4mm		12.8
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	111.8
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	218
16.	Days Man Labor needed/ha 51 x 2.04		104.0
17.	Hours draft animals work/ha. 40		

*FAO yields & inputs from Djilma Delegation; price data from CNEA.
(Budget prepared by Monia Bouratbine, CNEA.)

*Budget No. 6 - Vegetable Enterprise Budget - POTATOES

Central Tunisia Area: Delegation Djilma Sector _____

Kind of Crop Potatoes Dryland ( ); Irrigated (XX)

Description _____

1.	Yield: Ton per hectare		15
2.	Price, Dinars per Ton	D	90
3.	GROSS INCOME per hectare	D	1,350
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs Manure, 20t x 5	D	100.0
6.	Fertilizer & Lime. Nitrogen 3.00 x 500, Phosphate 3.60x3.6 Potash 4.0 x 7.6		56.2
7.	Seed 20 A x 12		240.0
8.	Crop Chemicals & Supplies Altrax 40 kg. x 0.232		9.2
9.	Custom machine hire. 20 hrs. x 1.9		38.5
10.	Machinery: fuel, repairs, etc.		
11.	Feed & Supplies for draft animals.		
12.	Miscellaneous Costs. Chemicals - Mineb 10 kg x .63		6.3
13.	Other. Water 3.800m 3 x 4mm		15.2
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	455.8
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	894.2
16.	Days Man Labor needed/ha 110 days x 2.04		224.4
17.	Hours draft animals work/ha.		

*FAO yields & inputs from Djilma Delegation; price data from CNEA.
(Budget prepared by Monia Bouratbine, CNEA.)

*Budget No. 7 - Vegetable Enterprise Budget - TOMATOES

Central Tunisia Area: Delegation Djilma Sector _____

Kind of Crop Tomatoes Dryland ( ); Irrigated (X)

Description _____

1.	Yield: Tons per hectare.	D	20
2.	Price, Dinars per Ton	D	56
3.	GROSS INCOME per hectare	D	1,120
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs . Manure (20t x 5D)	D	100.0
6.	Fertilizer & Lime. Nitrogen 3 x 5, Phosphate 3 x 3.6 Potash 3 x 7.7		48.9
7.	Seed . 15,000 plants x 2mm		37.5
**8.	Crop Chemicals & Supplies		55.5
9.	Custom machine hire. . . . 20 hours x 1.9		38.5
10.	Machinery: fuel, repairs, etc.		_____
11.	Feed & Supplies for draft animals.		_____
12.	Miscellaneous Costs.		_____
13.	Other. Water 7,400m 3 x 4mm		29.6
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	310
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	810
16.	Days Man Labor needed/ha . . 180 days x 2.04		367.2
17.	Hours draft animals work/ha.		_____

*FAO yields & inputs from Djilma Delegation; price data from CNEA.
(Budget prepared by Monia Bouratbine, CNEA.)

**Altra 40 kg. x 0.232
Soufe 1a x 11.760
Phosdrine- 10.a5 liters - x 1.683
Nanebe 10.5 liters x .630

*Budget No. 8 - Vegetable Enterprise Budget - TURNIPS

Central Tunisia Area: Delegation Djilma Governate: Sidi Bouzid Sector _____

Kind of Crop Turnips Dryland ( ); Irrigated (XX)

Description _____

1.	Yield: Tons per hectare.	D	30
2.	Price, Dinars per Ton	D	23
3.	GROSS INCOME per hectare	D	690
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs Manure 10t x 5.0	D	50.0
6.	Fertilizer & Lime. (Phosphate 2.5 Q x 3.6) (Potash 1.5 Quintals x 7.20)		20.6
7.	Seed . 7 kg. x 3 D.		21.0
8.	Crop Chemicals & Supplies Altrax 40 kg Q 23		9.2
9.	Custom machine hire. 12 hrs. x 1.9 D		23.1
10.	Machinery: fuel, repairs, etc.		
11.	Feed & Supplies for draft animals.		
12.	Miscellaneous Costs. . . Water		14.0
13.	Other. . (3,500m 3 x 4 ml.		
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	137.9
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	552.1
16.	Days Man Labor needed/ha . 54.5 x 2.04		110.2
17.	Hours draft animals work/ha. . . . . 3 hours		

*FAO yields & inputs from Djilma Delegation; price data from CNEA.
(Budget prepared by Monia Bouratbine, CNEA.)

*Budget No. 9 - Crop Enterprise Budget - ALFALFA

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Alfalfa Dryland ( ); Irrigated (X)

Description Green Chop

1.	Yield: Tons per hectare. . . . . D	30
2.	Price, Dinars per Ton . . . . . D	9.500
3.	GROSS INCOME per hectare . . . . . D	285.000
4.	VARIABLE COSTS PER HECTARE:	
5.	Land preparation costs . . . . . D	
6.	Fertilizer (1 Q/ha superphosphate) + (1 Q/ha Amon. nitrate) + (1 Q/ha Potash)	20.200
7.	Seed . 15 kg. x 1.500	22.500
8.	Crop Chemicals & Supplies	
9.	Custom machine hire.	
10.	Machinery: fuel, repairs, etc.	
11.	Feed & Supplies for draft animals.	
12.	Miscellaneous Costs.	
13.	Other. 20 working/man days x 2.000	40.000
14.	TOTAL VARIABLE COSTS (cal. 5-13) . . . . . D	82.700
15.	GROSS MARGIN PER HECTARE (L. 3-L.14) . . . . . D	202.300
16.	Days Man Labor needed/ha	
17.	Hours draft animals work/ha.	

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 10 - Crop Enterprise Budget - BARLEY (irrigated)

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Barley Dryland ( ); Irrigated (x)

Description Harvested for grain

1.	Yield: quintals per hectare	D	10
2.	Price, Dinars per quintal	D	4.000
3.	GROSS INCOME per hectare	D	40.000
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	
6.	Fertilizer (1 Q/ha Super Phosphate 1 Q/ha Amon Nitrate)		9.300
7.	Seed . 80 kg. x 4.400		3.520
8.	Crop Chemicals & Supplies		
9.	Custom machine hire. 8 hrs. x 2.000 + 4.000		20.000
10.	Machinery: fuel, repairs, etc.		
11.	Feed & Supplies for draft animals		
12.	Miscellaneous Costs		
13.	Other. 6 working man-days 1.200		7.200
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	40.020
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	(0.020)
16.	Days Man Labor needed/ha		
17.	Hours draft animals work/ha		

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 11 - Crop Enterprise Budget - BARLEY
(Dryland)

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Barley Dryland (XX); Irrigated ( )

Description	Improved	Present
1. Yield: Quintals per hectare	8 D	4
2. Price, Dinars per Quintal	4 D	4.000
3. GROSS INCOME per hectare	32.000 D	16.000
4. VARIABLE COSTS PER HECTARE:		
5. Land preparation costs	D	
6. Fertilizer** 80 KG/HA = D 4.800/ha	3.700	0
7. Seed 70 Kg x 5500 the quintal	4.800	3.850
8. Crop Chemicals & Supplies		
9. Custom machine hire. 3 h x 2000 + 4.000 threshing	10.000	10.000
10. Machinery: fuel, repairs, etc.		
11. Feed & Supplies for draft animals		
12. Miscellaneous Costs		
13. Other. 5 working man-days x 1.200		6.000
14. TOTAL VARIABLE COSTS (cal. 5-13)	18.500 D	9.850
15. GROSS MARGIN PER HECTARE (L. 3-L.14)	13.500 D	6.150
16. Days Man Labor needed/ha	10 days	5 days
17. Hours draft animals work/ha		

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

**50 kgs. N/ha @ D 0.038 = D 1.900
50 kgs. P_2O_5/ha @ D 0.036 = D 1.800
D 3.700 (Rates used at Ousseltia station)

*Budget No. 12 - Crop Enterprise Budget - CACTUS

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Cactus Dryland (XX); Irrigated ( )

Description _____

1.	Yield: _____ per hectare. . . . . D	_____
2.	Price, Dinars per _____ . . . . . D	_____
3.	GROSS INCOME per hectare (Fruit and Leaves) . . . . . D	30.000
4.	VARIABLE COSTS PER HECTARE:	
5.	Land preparation costs . . . . . D	5.000
6.	Fertilizer & Lime.	_____
7.	Seed	_____
8.	Crop Chemicals & Supplies	_____
9.	Custom machine hire.	_____
10.	Machinery: fuel, repairs, etc.	_____
11.	Feed & Supplies for draft animals.	_____
12.	Miscellaneous Costs. Harvesting	5.000
13.	Other.	5.000
14.	TOTAL VARIABLE COSTS (cal. 5-13) . . . . . D	15.000
15.	GROSS MARGIN PER HECTARE (L. 3-L.14) ** . . . . . D	15.000
16.	Hours Man Labor needed/ha	5
17.	Hours draft animals work/ha.	_____

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

**While no income was figured from grazing, this is considered a safety factor.

***Source: Best team estimate on basis of farm interview.

*Budget No. 13 - Crop Enterprise Budget - DURUM WHEAT (irrigated)

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Durum Wheat Dryland ( ); Irrigated (X)

Description _____

1.	Yield: Quintals per hectare.	D	12
2.	Price, Dinars per Quintal	D	6.000
3.	GROSS INCOME per hectare	D	72.000
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	
6.	Fertilizer & Lime. (1 Q/ha super phosphate) + (1 Q/ha Amon. nitrate)		9.300
7.	Seed 1 quintal		8.000
8.	Crop Chemicals & Supplies		
9.	Custom machine hire. 9 hrs (8.5 x 2.000) (0.5 x 8.000) combine		17.000 4.000
10.	Machinery: fuel, repairs, etc.		
11.	Feed & Supplies for draft animals.		
12.	Miscellaneous Costs.		
13.	Other. 6 working man days x 1.200		7.200
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	45.500
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	26.500
16.	Days Man Labor needed/ha		
17.	Hours draft animals work/ha.		

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 14 - Crop Enterprise Budget - DURUM WHEAT (dryland)

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Durum Wheat Dryland (X); Irrigated ( )

Description		Present
1. Yield: Quintals per hectare	D	4
2. Price, Dinars per Quintal	D	4.000
3. GROSS INCOME per hectare	D	16.000
4. VARIABLE COSTS PER HECTARE:		
5. Land preparation costs	D	
6. Fertilizer & Lime		
7. Seed 80 kg x 6.500		5.200
8. Crop Chemicals & Supplies		
9. Custom machine hire 4 hours x 2.000 + 4.000 hauling		12.000
10. Machinery: fuel, repairs, etc.		
11. Feed & Supplies for draft animals		
12. Miscellaneous Costs		
13. Other 5 working man days x 1.200		
14. TOTAL VARIABLE COSTS (cal. 5-13)	D	17.200
15. GROSS MARGIN PER HECTARE (L. 3-L.14)	D	1.200
16. Days Man Labor needed/ha		5
17. Hours draft animals work/ha		

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 15 - Crop Enterprise Budget - OATS (only)

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Oats (only) Dryland (X); Irrigated ( )

Description Harvested for Forage

1.	Yield: Ton per hectare.	D	2.5
2.	Price, Dinars per Ton	D	30.000
3.	GROSS INCOME per hectare	D	75.000
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	_____
6.	Fertilizer & Lime.		_____
7.	Seed 8.000		8.000
8.	Crop Chemicals & Supplies		_____
9.	Custom machine hire. 8 hours x 2.000		16.000
10.	Machinery: fuel, repairs, etc.		_____
11.	Feed & Supplies for draft animals.		_____
12.	Miscellaneous Costs.		_____
13.	Other. .7 working man days x 1.200		8.400
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	32.400
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	42.600
16.	Days Man Labor needed/ha		_____
17.	Hours draft animals work/ha.		_____

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 16 - Crop Enterprise Budget - VETCH/OATS

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Vetch/Oats Dryland ( ); Irrigated (X)

Description Harvested for Forage

1.	Yield: Tons per hectare.	D	4
2.	Price, Dinars per Ton	D	40.000
3.	GROSS INCOME per hectare	D	160.000
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	
6.	Fertilizer & Lime. 1 Q/ha Super Phosphate 1 Q/ha Amon Nitrate		9.300
7.	Seed 60 kg vetch 40 kg oats 1 quintal		1.500
8.	Crop Chemicals & Supplies		
9.	Custom machine hire. 10 hours x 2.000		20.000
10.	Machinery: fuel, repairs, etc.		
11.	Feed & Supplies for draft animals.		
12.	Miscellaneous Costs.		
13.	Other. 10 working man days x 1.200		12.000
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	42.800
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	117.200
16.	Days Man Labor needed/ha		
17.	Hours draft animals work/ha.		

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 17 - Vegetable Budget - BROAD BEANS

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Broad Beans Dryland ( ); Irrigated (X)

Description _____

1.	Yield: Tons per hectare. . . . . D	6
2.	Price, Dinars per Ton . . . . . D	40.000
3.	GROSS INCOME per hectare . . . . . D	240.000
4.	VARIABLE COSTS PER HECTARE:	
5.	Land preparation costs . . . . . D	
6.	Fertilizer & Lime. (2 Q/ha super Phosphate)+(1 Q/ha Potash)+ (42.D000 manure)	58.000
7.	Seed 130 kg x 0.425	55.250
8.	Crop Chemicals & Supplies Fosdine (1 Q/ha)	1.600
9.	Custom machine hire.	
10.	Machinery: fuel, repairs, etc.	
11.	Feed & Supplies for draft animals.	
12.	Miscellaneous Costs. 60 working man days	90.000
13.	Other. Water 6000 M3	24.000
14.	TOTAL VARIABLE COSTS (cal. 5-13) . . . . . D	228.850
15.	GROSS MARGIN PER HECTARE (L. 3-L.14) . . . . . D	11.150
16.	Days Man Labor needed/ha	
17.	Hours draft animals work/ha.	

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 18 - Vegetable Budget - CARROTS

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Carrots Dryland ( ); Irrigated (X)

Description 22 Tons

1.	Yield: Tons per hectare.		10
2.	Price, Dinars per Ton	D	40.000
3.	GROSS INCOME per hectare	D	400.000
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	_____
6.	Fertilizer & Lime. Manure 5 trucks x 7.000		35.000
7.	Seed 10 kg x 6.000		60.000
8.	Crop Chemicals & Supplies Aldrex 30 kg.		7.000
9.	Custom machine hire.		_____
10.	Machinery: fuel, repairs, etc.		_____
11.	Feed & Supplies for draft animals.		_____
12.	Miscellaneous Costs. 40 working man days		60.000
13.	Other. Water 3.500 x 4		14.000
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	176.000
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	224.000
16.	Days Man Labor needed/ha		_____
17.	Hours draft animals work/ha.		_____

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 19 - Vegetable Budget - MELONS/ZUCCHINI

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Melons/Zucchini Dryland ( ); Irrigated (xx)

Description _____

1.	Yield: tons per hectare		14
2.	Price, Dinars per ton	D	35.000
3.	GROSS INCOME per hectare	D	490.000
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	_____
6.	Fertilizer & Lime (1.5Q/ha super phosphate)+(1Q/ha Potash)+(105.000d manure)		120.000
7.	Seed 4 kg. x 5.000		20.000
8.	Crop Chemicals & Supplies (Sulpher-30 kg. x 2)+ (Potash 30x1)		10.000
9.	Custom machine hire		_____
10.	Machinery: fuel, repairs, etc.		_____
11.	Feed & Supplies for draft animals		_____
12.	Miscellaneous Costs. 50 working man-days 1.500		75.000
13.	Other. Water 4/500 M3		18.000
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	243.000
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	247.000
16.	Days Man Labor needed/ha		_____
17.	Hours draft animals work/ha		_____

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 20 - Vegetable Budget - ONIONS

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Onions (in season) Dryland ( ); Irrigated (xx)

Description _____

1.	Yield: tons per hectare.		20
2.	Price, Dinars per ton	D	60.000
3.	GROSS INCOME per hectare	D	1200.000
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	_____
6.	Fertilizer & Lime. (manure 5 trucks x 7.500) (1.5Q/ha super phosphate)		43.200
7.	Seed 30.000 plants x 2		60.000
8.	Crop Chemicals & Supplies Aldrex 30 kg.		7.300
9.	Custom machine hire.		_____
10.	Machinery: fuel, repairs, etc.		_____
11.	Feed & Supplies for draft animals.		_____
12.	Miscellaneous Costs. 50 man days		75.000
13.	Other. Water x 5000 M3		20.000
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	205.500
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	994.500
16.	Days Man Labor needed/ha		_____
17.	Hours draft animals work/ha.		_____

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 21 - Vegetable Budget - PEPPERS

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Peppers (in season) Dryland ( ); Irrigated (xx)

Description _____

1.	Yield: tons per hectare.	10
2.	Price, Dinars per ton . . . . . D	75.000
3.	GROSS INCOME per hectare . . . . . D	750.000
4.	VARIABLE COSTS PER HECTARE:	
5.	Land preparation costs . . . . . D	
6.	(2Q/ha amon. nitrate)+(2.5Q/ha super phosphate)+(2A/ha Potash)+(84.000d manure) Fertilizer & Lime.	112.000
7.	22.000 plants x 3 Seed	66.000
8.	Crop-Chemicals & Supplies	
9.	Custom machine hire.	
10.	Machinery: fuel, repairs, etc.	
11.	Feed & Supplies for draft animals.	
12.	Miscellaneous Costs. 100 working man-days x 1.500	150.000
13.	Other. Water 8000 M3	32.000
14.	TOTAL VARIABLE COSTS (cal. 5-13) . . . . . D	360.000
15.	GROSS MARGIN PER HECTARE (L. 3-L.14) . . . . . D	390.000
16.	Days Man Labor needed/ha	
17.	Hours draft animals work/ha.	

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 22 - Vegetable Budget - POTATOES
(in season)

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Potatoes (in season) Dryland ( ); Irrigated ( )

Description _____

1. Yield: _____ per hectare. . . . . _____

2. Price, Dinars per _____ . . . . . D _____

3. GROSS INCOME per hectare . . . . . D _____ *

4. VARIABLE COSTS PER HECTARE:

5. Land preparation costs . . . . . D _____

6. Fertilizer & Lime. . . . . _____

7. Seed . . . . . _____

8. Crop Chemicals & Supplies . . . . . _____

9. Custom machine hire. . . . . _____

10. Machinery: fuel, repairs, etc. . . . . _____

11. Feed & Supplies for draft animals. . . . . _____

12. Miscellaneous Costs. . . . . _____

13. Other. . . . . _____

14. TOTAL VARIABLE COSTS (cal. 5-13) . . . . . D _____

15. GROSS MARGIN PER HECTARE (L. 3-L.14) . . . . . D _____ *

16. Days Man Labor needed/ha . . . . . _____

17. Hours draft animals work/ha. . . . . _____

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Almost same as Out of Season

*Budget No. 23 - Vegetable Budget - POTATOES (out of season)

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Potatoes (out of season) Dryland ( ); Irrigated (x)

Description _____

1.	Yield: tons per hectare.		8
2.	Price, Dinars per ton	D	120.000
3.	GROSS INCOME per hectare	D	960.000
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	_____
6.	Fertilizer & Lime. (3Q/ha Potash)+(2Q/ha Amon. nitrate)+ (3Q/ha super phosphate)+100.000 for manure		150.000
7.	Seed		_____
8.	Crop Chemicals & Supplies Aldrex 30 kg.		0.800
9.	Custom machine hire. 20 hrs. x 1.800		36.000
10.	Machinery: fuel, repairs, etc.		_____
11.	Feed & Supplies for draft animals.		_____
12.	Miscellaneous Costs. 120 working man days x 1.500 . . .		180.000
13.	Other. . . . . Water 6000 M3 x 4		24.000
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	390.800
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	569.200
16.	Days Man Labor needed/ha		_____
17.	Hours draft animals work/ha.		_____

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 24 - Vegetable Budget - TOMATOES

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Tomatoes (in season) Dryland ( ); Irrigated (x)

Description _____

1.	Yield: tons per hectare.		20
2.	Price, Dinars per ton	D	36.000
3.	GROSS INCOME per hectare	D	720.000
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	_____
6.	Fertilizer & Lime. (2Q/ha amon. nitrate)+(2.5Q/ha Super Phosphate)+(2Q/ha potash)+(84.000 manure)		_____
7.	Seed 15,000 plants x 3 millimes		45.000
8.	Crop Chemicals & Supplies Sulfur 75 kg. x 0.115+ Detane		9.000
9.	Custom machine hire.		_____
10.	Machinery: fuel, repairs, etc.		_____
11.	Feed & Supplies for draft animals.		_____
12.	Miscellaneous Costs. 100 working man-days x 1.500		150.000
13.	Other. Water for irrigation 8000 m^3 x 4		32.000
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	348.5000
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	371.500
16.	Days Man Labor needed/ha		_____
17.	Hours draft animals work/ha.		_____

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 25 - Vegetable Budget - TURNIPS

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Turnips Dryland ( ); Irrigated (x)

Description _____

1.	Yield: tons per hectare		10
2.	Price, Dinars per ton	D	50.000
3.	GROSS INCOME per hectare	D	500.000
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	
6.	Fertilizer & Lime. manure 5 trucks x 7.000		35.000
7.	Seed 4 kg. x 6.000		24.000
8.	Crop Chemicals & Supplies Aldrex 30 kg.		7.000
9.	Custom machine hire.		
10.	Machinery: fuel, repairs, etc.		
11.	Feed & Supplies for draft animals.		
12.	Miscellaneous Costs. 40 man working days x 1.5000		60.000
13.	Other. Water 3.500 M3 x 4		14.000
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	140.000
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	360.000
16.	Days Man Labor needed/ha		
17.	Hours draft animals work/ha.		

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 26 - Tree Crop Budget - ALMONDS

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Almonds Dryland (x); Irrigated ( )

Description _____

1.	Yield: kg. per hectare.		100
2.	Price, Dinars per kg.	D	0.350
3.	GROSS INCOME per hectare	D	35.000
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	
6.	Fertilizer & Lime.		
7.	Seed		
8.	Crop Chemicals & Supplies		1.000
9.	Custom machine hire. . . 6 hrs. x 2.000		12.000
10.	Machinery: fuel, repairs, etc.		
11.	Feed & Supplies for draft animals.		
12.	Miscellaneous Costs. . . harvesting) hired)labor		1.500
13.	Other. . . . . pruning) 1/2		6.000
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	20.500
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	14.500
16.	Days Man Labor needed/ha . . . 5 days		5
17.	Hours draft animals work/ha.		

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 27 - Tree Crop Budget - APPLES

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Apples Dryland ( ); Irrigated (X)

Description _____

1.	Yield: ton per hectare.		1.5
2.	Price, Dinars per ton	D	300.000
3.	GROSS INCOME per hectare	D	450.000
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	_____
6.	Fertilizer & Lime.		_____
7.	Seed . . . . . Pruning		10.000
8.	Crop Chemicals & Supplies		2.000
9.	Custom machine hire. . . . 6 hrs. x 2.000		12.000
10.	Machinery: fuel, repairs, etc.		_____
11.	Feed & Supplies for draft animals.		_____
12.	Miscellaneous Costs. . . . Harvesting & transport. . . .		8.000
13.	Other.		_____
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	32.000
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	418.000
16.	Days Man Labor needed/ha		_____
17.	Hours draft animals work/ha.		_____

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 28 - Tree Crop Budget - APRICOTS

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Apricots Dryland ( ); Irrigated (x)

Description _____

1. Yield: tons per hectare		3
2. Price, Dinars per ton	D	30.000
3. GROSS INCOME per hectare	D	90.000
4. VARIABLE COSTS PER HECTARE:		
5. Land preparation costs	D	
6. Fertilizer & Lime		
7. Seed . . . Pruning		10.000
8. Crop Chemicals & Supplies		2.000
9. Custom machine hire. . . 6 hrs. x 2.000		12.000
10. Machinery: fuel, repairs, etc.		
11. Feed & Supplies for draft animals		
12. Miscellaneous Costs. . . Harvesting etc.		8.000
13. Other. . . . . Water Irrigation		8.000
14. TOTAL VARIABLE COSTS (cal. 5-13)	D	40.000
15. GROSS MARGIN PER HECTARE (L. 3-L.14)	D	50.000
16. Days Man Labor needed/ha		
17. Hours draft animals work/ha		

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

*Budget No. 29 - Tree Crop Budget - OLIVES

Central Tunisia Area: Delegation Sbiba Sector _____

Kind of Crop Olives Dryland (xx); Irrigated ( )

Description 180 kg.

1.	Yield: kg. per hectare		180
2.	Price, Dinars per kg.	D	0.060
3.	GROSS INCOME per hectare	D	10.800
4.	VARIABLE COSTS PER HECTARE:		
5.	Land preparation costs	D	
6.	Fertilizer & Lime		
7.	Seed		
8.	Crop Chemicals & Supplies		
9.	Custom machine hire. 6 hrs. x 2.000		12.000
10.	Machinery: fuel, repairs, etc.		
11.	Feed & Supplies for draft animals		
12.	Miscellaneous Costs. Pruning 6.000 ± Harvesting ± Transport 4.500		10.000
13.	Other		10.500
14.	TOTAL VARIABLE COSTS (cal. 5-13)	D	32.000
15.	GROSS MARGIN PER HECTARE (L. 3-L.14)	D	(21.200)
16.	Days Man Labor needed/ha		
17.	Hours draft animals work/ha		

*Budget Data for Central Tunisia Project Area; from CRDA (Commisariat Regional de Development Agricole). (Prepared by Tahar Ben Salem.)

Note: based on young tree yields

**Budget No. 30 - Livestock Budget - SHEEP

Kind of Livestock Enterprise SHEEP ENTERPRISE

1. Description of Sales from Enterprise (from One Unit):*

Wool - 2'1/2 kg. x 0.740 TD/kg.	1.850 TD
Lambs - male - 24 kg. x .35 = 8.4 kg. x 0.750 TD/kg.	6.300 TD
female 25 kg. x .14 = 3.5 kg. x 0.650 TD/kg.	2.275 TD
Cull Ewes - 38 kg. x .20 = 7.6 kg. x 0.450 TD/kg.	3.420 TD

**2. GROSS RECEIPTS per Unit (dinars). . . . . D 13,845 TD

3. Cost of feed per Unit (dinars) + milk & manure income .02 TD

TOTAL 14.0 TD

a. Pasture . . . . . D ____

b. Other feed. Concentrate . . . . . D 0.800
(20 kg. x 40 m.)

4. Medicine. . . . . D 0.150

5. Misc. . . . . D 0.050

6. Other Marketing . . . . . D 0.280

7. Other Selling tax . . . . . D 0.050

**8. TOTAL VARIABLE COST per Unit. . . D 1.330

9. GROSS MARGIN per Unit (L.2 - L.8) D 12.67 (13.0 rounded)

10. Hours Man Labor Required per Unit 5 (estimated)

11. Investment Required per Unit. . . D 20 (estimated)

*One unit includes one ewe, lamb and portion of replacement for flock.
The budget assumes a 5-year productive life/ewe
--selling of .2 ewe per year and savings % of ewe lambs for replacement.

**Data received from CNEA (from Philippe Ardounin-Dumazet and Hafi Chedli)

APPENDIX SECTION D

Economic Evaluations of Sample Model Farming Systems

CENTRAL TUNISIA RURAL DEVELOPMENT PROJECT

Evaluation of Model Farming Systems

Form TU-1 CAPITAL INVESTMENT SUMMARY

Present System (X) or Improved System No.___

DESCRIPTION OF SYSTEM:

Kind of Land - **Dryland area, 10 acres, stony land, not tillable; e.g., Plateau area in Makthar Delegation.**
Crop & Livestock Enterprises - **(Shown on Forms TU-2 & TU-3)**

A. LAND INVESTMENT: 30 ha x 100 TD/ha ..... TD 3,000

B. FARM BUILDINGS:

1. Storage Bldg's..... TD 25
2. Corral..... TD 10
3. Other..... TD

4. Total bldg. Investments..... TD 35

C. TOOLS & EQUPMENTS:

1. Hand Tools..... TD 5
2. Field Equipment..... TD 20
3. **Transport.Equipment**..... TD 20
4. ..... TD

5. Total Equipment Investment..... TD 45

D. BREEDING ANIMALS:

1. Sheep.....No. (10 ewes 1 ram) x TD 20 /head..... TD 220
2. Goats.....No.____ x TD____/head..... TD
3. Cattle....No.____ x TD____/head..... TD

4. Total Breeding Animal Investment..... TD 220

E. WORK ANIMALS:

1. Donkeys...No. 2 x TD 25 /head..... TD 50
2. Mules.....No.____ x TD____/head..... TD
3. Horses....No.____ x TD____/head..... TD
4. Camels....No. 1 x TD 250 /head..... TD 250

5. Total Work Animal Investments..... TD 300

F. TOTAL INVESTMENT CAPITAL: ..... TD 3,600

***Since few land and equipment sales are reported in the area, the investments in land, buildings, equipment, and animals are approximations only for illustrating the evaluation procedure.**

Form TU-2

CENTRAL TUNISIA RURAL DEVELOPMENT PROJECT

Evaluation of Model Farming Systems

LAND USE SYSTEM

Kind of System: Present (X) or Improved System No. ____

Land Use*	Season In	Season Out	**No.of Hectares	Yield Ql./ha.	Total Product	***Gross Margin Per ha.	***Gross Margin Total	Days Labor*** Per ha.	Days Labor*** Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1 Barley			6	4	24	TD 6.15	TD 36.9	5	30
2 Fallow land (Past)			6	(Production & income from Sheep enterprise)				1	6
3 Tillable Past. Land			8	(Production & income from Sheep enterprise)				1	8
4 Non-tillable Past. Land			8	(Production & income from Sheep enterprise)				--	--
5									
6									
7									
8									
9									
10									
11									
12									
13 Waste Land	xx	xx	2	xxxx	xxxx	xxx	xxx	xxx	xxx
14 TOTALS	xx	xx	30	xxxx	xxxx	xxx	36.9	xxx	44

* Includes cereal crops, forage crops, pastures, vegetables, fruits & nuts, fallow, & waste land.
** In case of double or multiple cropping, circle (ha) for succeeding crops and omit from total.
*** Gross Margins and Total Days Labor should be transferred directly from individual budgets.

CENTRAL TUNISIA RURAL DEVELOPMENT PROJECT

Evaluation of Model Farming Systems

Form TU-3

LIVESTOCK SYSTEM

Kind of System: Present (X); Improved No. _____

Kind of Enterprise	No of Units*	Gross Margin**		Days Labor Used***	
		TD/Unit	TD Total	Per Unit	Total
(1)	(2)	(3)	(4)	(5)	(6)
1. Sheep (10 ewes; 1 ram)	10	13.0	130	5	50
2.					
3.					
4.					
5.					
6.					
7. TOTALS FOR SYSTEM	xxxx	xxxx	130	xxxx	50

* Units refer to the breeding unit or no. of head as described in Enterprise Budgets.

** Gross Margins and Days Labor Used may be taken directly from the Enterprise Budgets already prepared.

CENTRAL TUNISIA RURAL DEVELOPMENT PROJECT

Economic Evaluation of Model Farming Systems

Form TU-4 PROFITABILITY ANALYSIS

Kind of System: Present (X); Improved No. ____

Line	Item	Details	Total
	(1)	(2)	(3)
1.	TOTAL INVESTMENT CAPITAL (Form TU-1, Line F).	TD ____	TD 3,600
	LABOR--		
2.	Crop Labor Days (Form TU-2, Col. 10)	TD 44	
3.	Livestock Labor Days (Form TU-3, Col. 6) . .	TD 50	
4.	Miscellaneous Farm Labor (Est. days)	TD 16	
5.	Total Days Farm Labor.	xxxx	TD 110
	GROSS MARGIN--		
6.	From Cropping System (Form TU-2, Col. 8) . .	TD 36.9	
7.	From Livestock System (Form TU-3, Col. 4) .	TD130.0	
8.	Total.	xxxx	TD 167
	OTHER CASH COSTS--		
9.	Hired Labor: (a) 0 days X (b) 2.0TD/day . .	TD --	
10.	Cash Rent.	TD --	
11.	Rent in Kind: Cash Value.	TD --	
12.	Misc. Expense: 2% of Line 8	TD 3.5	
13.	Other.	TD .5	
14.	Total Other Cash Costs	xxxx	TD 4.0
15.	NET CASH FARM INCOME (Line 8-Line 14) . . .	xxxx	TD 163.0
16.	DEPRECIATION ALLOWANCE: Equip. & Buildings	xxxx	TD 5.0
17.	Cash Income above Depreciation (Line 15-16)	xxxx	TD 158.0
18.	Cash Value Farm-Produced Family Food (est.)	xxxx	TD 242.0
19.	FARM PROFIT (Line 17 + Line 18).	xxxx	TD 400.0
20.	Return to Family Labor & Mgt. [L.19-(L.1 X 6 %)].	xxxx	TD 184.0
21.	Return per Day [L.20÷(L.5-L.9a)]	xxxx	TD 1.67
22.	Return to Capital [L.19-(L.5-L.9a X L.9b)] .	xxxx	TD 180.0
23.	% Return to Capital (L.22÷L.1 X 100)	xxxx	% 5.0

Form TU-5

CENTRAL TUNISIA RURAL DEVELOPMENT PROJECT

Economic Evaluation of Model Farming Systems

ECONOMIC FEASIBILITY (CASH-FLOW) ANALYSIS

Kind of System: Present (X); Improved No. ____

	Item	Details	Total
	(1)	(2)	(3)
1	Net Cash Farm Income (Form TU-4, L.15).	TD 163	
2	Cash Rent Received.	TD --	
3	Wages from off-farm work.	TD 57	
4	Other Cash Family Income.	TD --	
5	TOTAL CASH FAMILY INCOME.	xxxxx	TD 220
	CASH FAMILY EXPENSES:	xxxxx	
6	Family Clothing	TD 20	
7	Family Food	TD 100	
8	Weddings, Religious Ceremonies, etc. .	TD 50	
9	Interest paid in Cash	TD 10	
10	Other Cash Family Expenses.	TD 20	
11	TOTAL CASH FAMILY EXPENSES.	xxxx	TD 200
12	*NET CASH FAMILY INCOME (L.5-L.11). . .	xxxx	TD 20

*Cash available for savings, debt payments, and new investments.

Form TU-6

CALCULATION OF FORMULA FOR INVESTMENT SELECTION
(Blackton Formula)

Formula: $\left(\frac{\Delta I}{I}\right) C^{-1}$

I - Present Net Cash Farm Income

Δ I - Change in Net Cash Farm Income

C - Development Cost per Farm (as derived from project Analysis)

	Item	Amount
1	Net Cash Farm Income: Improved System	TD_____
2	Net Cash Farm Income: Present System.	TD_____
3	Change in Net Cash Farm Income (L.9-L.2) . . .	TD_____
4	Ratio of Change in Income to Present Income (L.3 ÷ L.2).	TD_____

CENTRAL TUNISIA RURAL DEVELOPMENT PROJECT

Evaluation of Model Farming Systems

Form TU-1 CAPITAL INVESTMENT SUMMARY

Present System ( ) or Improved System No. A

DESCRIPTION OF SYSTEM:

Kind of Land -

Crop & Livestock Enterprises -

A. LAND INVESTMENT: 30 ha x 100 TD/ha ..... TD 3,000

B. FARM BUILDINGS:

1. Storage Bldg's..... TD 25
2. Corral..... TD 10
3. Other..... TD

4. Total bldg. Investments..... TD 35

C. TOOLS & EQUPMENTS:

1. Hand Tools..... TD 5
2. Field Equipment..... TD 20
3. Transport.Equipment..... TD 20
4. ..... TD

5. Total Equipment Investment..... TD 45

D. BREEDING ANIMALS:

1. Sheep.....No. (15 ewes, 1 ram) x TD 20 /head..... TD 320
2. Goats.....No. ____ x TD ____/head..... TD
3. Cattle....No. ____ x TD ____/head..... TD

4. Total Breeding Animal Investment..... TD 320

E. WORK ANIMALS:

1. Donkeys...No. 2 x TD 25 /head..... TD 50
2. Mules.....No. ____ x TD ____/head..... TD
3. Horses....No. ____ x TD ____/head..... TD
4. Camels....No. 1 x TD 250 /head..... TD 250

5. Total Work Animal Investments..... TD 300

F. TOTAL INVESTMENT CAPITAL: ..... TD 3,700

Form TU-2

CENTRAL TUNISIA RURAL DEVELOPMENT PROJECT

Evaluation of Model Farming Systems

LAND USE SYSTEM

Kind of System: Present ( ) or Improved System No. A

Land Use*	Season In	Season Out	**No.of Hectares	Yield ___/ha.	Total Product	***Gross Margin Per ha.	***Gross Margin Total	Days Labor*** Per ha.	Days Labor*** Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1 Barley (Improved)	--	--	8	8 Ql/ha.	64 Ql.	13.5	108	10	80
2 Almonds	--	--	2	100 Kg/ha.	200 Kg.	14.5	29	5	10
3 Rotation Pasture	--	--	10	(Production & Income from Sheep Enterprise)				2	20
4 Non-Rotation Pasture	--	--	8	(Production & Income from Sheep Enterprise)				--	--
5									
6									
7									
8									
9									
10									
11									
12									
13 Waste Land	xx	xx	2	xxxx	xxxx	xxx	xxx	xxx	xxx
14 TOTALS	xx	xx		xxxx	xxxx	xxx	137	xxx	110

* Includes cereal crops, forage crops, pastures, vegetables, fruits & nuts, fallow, & waste land.

** In case of double or multiple cropping, circle (ha) for succeeding crops and omit from total.

*** Gross Margins and Total Days Labor should be transferred directly from individual budgets.

CENTRAL TUNISIA RURAL DEVELOPMENT PROJECT

Evaluation of Model Farming Systems

Form TU-3

LIVESTOCK SYSTEM

Kind of System: Present ( ); Improved No. A

Kind of Enterprise	No of Units*	Gross Margin**		Days Labor Used***	
		TD/Unit	TD Total	Per Unit	Total
(1)	(2)	(3)	(4)	(5)	(6)
1. **Sheep (15 ewes, 1 ram)**	15	13	195	5	75
2.					
3.					
4.					
5.					
6.					
7. TOTALS FOR SYSTEM	xxxx	xxxx	195	xxxx	75

* Units refer to the breeding unit or no. of head as described in Enterprise Budgets.

** Gross Margins and Days Labor Used may be taken directly from the Enterprise Budgets already prepared.

CENTRAL TUNISIA RURAL DEVELOPMENT PROJECT

Economic Evaluation of Model Farming Systems

Form TU-4 PROFITABILITY ANALYSIS

Kind of System: Present ( ); Improved No. A

Line	Item	Details	Total
	(1)	(2)	(3)
1.	TOTAL INVESTMENT CAPITAL (Form TU-1, Line F).	TD	TD 3,700
	LABOR--		
2.	Crop Labor Days (Form TU-2, Col. 10)	TD 110	
3.	Livestock Labor Days (Form TU-3, Col. 6) . .	TD 75	
4.	Miscellaneous Farm Labor (Est. days)	TD 10	
5.	Total Days Farm Labor.	xxxx	TD 195
	GROSS MARGIN--		
6.	From Cropping System (Form TU-2, Col. 8) . .	TD 137	
7.	From Livestock System (Form TU-3, Col. 4) .	TD 195	
8.	Total.	xxxx	TD 332
	OTHER CASH COSTS--		
9.	Hired Labor: (a) 0 days X (b) 2.0TD/day . .	TD --	
10.	Cash Rent.	TD --	
11.	Rent in Kind: Cash Value.	TD --	
12.	Misc. Expense: 2% of Line 8	TD 6.6	
13.	Other.	TD .4	
14.	Total Other Cash Costs	xxxx	TD 7
15.	NET CASH FARM INCOME (Line 8-Line 14) . . .	xxxx	TD 325
16.	DEPRECIATION ALLOWANCE: Equip. & Buildings	xxxx	TD 5
17.	Cash Income above Depreciation (Line 15-16)	xxxx	TD 320
18.	Cash Value Farm-Produced Family Food (est.)	xxxx	TD 275
19.	FARM PROFIT (Line 17 + Line 18).	xxxx	TD 595
20.	Return to Family Labor & Mgt. [L.19-(L.1 X 6 %)].	xxxx	TD 373
21.	Return per Day [L.20÷(L.5-L.9a)]	xxxx	TD 1.91
22.	Return to Capital [L.19-(L.5-L.9a X L.9b)] .	xxxx	TD 205
23.	% Return to Capital (L.22÷L.1 X 100)	xxxx	% 5.54

Form TU-5

CENTRAL TUNISIA RURAL DEVELOPMENT PROJECT

Economic Evaluation of Model Farming Systems

ECONOMIC FEASIBILITY (CASH-FLOW) ANALYSIS

Kind of System: Present ( ); Improved No. A

	Item	Details	Total
	(1)	(2)	(3)
1	Net Cash Farm Income (Form TU-4, L.15).	TD 325	
2	Cash Rent Received.	TD --	
3	Wages from off-farm work.	TD 57	
4	Other Cash Family Income.	TD --	
5	TOTAL CASH FAMILY INCOME.	xxxxx	TD 382
	CASH FAMILY EXPENSES:	xxxxx	
6	Family Clothing	TD 20	
7	Family Food	TD 100	
8	Weddings, Religious Ceremonies, etc. .	TD 50	
9	Interest paid in Cash	TD 10	
10	Other Cash Family Expenses.	TD 20	
11	TOTAL CASH FAMILY EXPENSES.	xxxx	TD 200
12	*NET CASH FAMILY INCOME (L.5-L.11). . .	xxxx	TD 182

*Cash available for savings, debt payments, and new investments.

Form TU-6 CALCULATION OF FORMULA FOR INVESTMENT SELECTION
(Blackton Formula)

Formula: $\left(\frac{\Delta I}{I}\right) C^{-1} =$

$\frac{162}{20} = 8.1\ C^{-1}$

I - Present Net Cash Farm Income

ΔI - Change in Net Cash Farm Income

C - Development Cost per Farm (as derived from project Analysis)

	Item	Amount
1	Net Cash Farm Income: Improved System	TD 182
2	Net Cash Farm Income: Present System.	TD 20
3	Change in Net Cash Farm Income (L.9-L.2) . . .	TD 162
4	Ratio of Change in Income to Present Income (L.3 ÷ L.2).	TD 8.1

APPENDIX SECTION E

USAID Assignment for Central Tunisia Rural Development Project

UNITED STATES OF AMERICA
AGENCY FOR INTERNATIONAL DEVELOPMENT

1. Country of performance Tunisia

2. Mark one and insert appropriate numbers:
- ☒ Indefinite Quantity Contract No. AID/Afr-C-1139, Work Order No. 5
- ☐ Requirements Contract No. _____, Delivery Order No. _____
- ☐ Basic Ordering Agreement No. _____, Task Order No. _____

NEGOTIATED PURSUANT TO THE FOREIGN ASSISTANCE ACT OF 1961, AS AMENDED, AND EXECUTIVE ORDER 11223

3. CONTRACTOR (Name and Address):	4. CONTRACTING OFFICE (Name and Address):
The Curators of the University of Missouri 215 University Hall Columbia, Missouri 65201	Agency for International Development Office of Contract Management Regional Operations Division-NE Washington, D.C. 20523
5. PROJECT OFFICE (Name and Address):	**6. SUBMIT VOUCHERS TO (Office Name and Address):**
Bureau for Near East Office of Technical Support (NE/TECH) Agency for International Development Washington, D.C. 20523	Office of Financial Management (SER/PAD) Agency for International Development Washington, D.C. 20523
7. EFFECTIVE DATE: February 22, 1978	**8. ESTIMATED COMPLETION DATE:** June 10, 1978

9. ACCOUNTING AND APPROPRIATION DATA (Insert appropriate numbers):

Amount Obligated: $46,000 PIO/T No.: 298-035-3-6287005

Appropriation No. 72-1181021.3 Allotment No.: 843-62-298-00-69-81

10. The United States of America, represented by the Contracting Officer signing this Order, and the Contractor agree that: (a) this Order is issued pursuant to the Contract or Agreement specified in Block 2 above and (b) the entire Contract between the parties hereto consist of this Order and the Contract or Agreement specified in Block 2 above.

11a. NAME OF CONTRACTOR:	11b. UNITED STATES OF AMERICA AGENCY FOR INTERNATIONAL DEVELOPMENT
The Curators of the University of Missouri	
BY (Signature of authorized individual):	BY (Signature of Contracting Officer):
[signature]	[signature]
TYPED OR PRINTED NAME:	TYPED OR PRINTED NAME:
[illegible]	Franklin H. Moulton WK
TITLE:	TITLE:
[illegible]	CONTRACTING OFFICER
DATE:	DATE:

Work Order No. 5 to
Contract AID/Afr-C-1139

I. AID PROJECT TITLE

Project Development and Support (Central Tunisia Rural Development).

II. OBJECTIVE

The objective of the work order is to provide an assessment of the agricultural potential of central Tunisia.

A. The specific objective of the team will be:

1. to make a systematic analysis of the agricultural potential of the proposed project area and research and technical assistance requirements for long-term development;

2. to develop alternative strategies for agricultural development of the proposed program area over the next several years and assess present GOT technical research strengths relating to semi-arid agricultural problems of central Tunisia; and

3. to indicate the relative feasibility and priority of specific potential agricultural development activities and assess status of existing linkages between GOT semi-arid staff and international semi-arid agriculture research efforts.

4. the team shall also ascertain whether there are special agricultural technological packages with a moderate to high economic return potential now in existence or under development which can soon be deployed in an area like central Tunisia; and if so, determine extent of their potential applicability in terms of hectarage, farm units, and overall production. The team shall identify range of possible agricultural

activities that might warrant detailed project development with indication of their relative priority and likely feasibility for U.S. support during next several years.

III. Team Members and Qualifications

A. To accomplish the objectives herein, the Contractor shall provide a team of four (4) specialists listed as follows:

1. An Agricultural Economist with experience in capital projects analysis including financial and economic analysis, shall review and accumulate existing information on farm size, farm resources, present levels of crop and animal production, labor, markets, credit, extension services, transport facilities, and prepare sample farm budgets.

2. An Agronomist/Range Management Specialist with extensive experience in assessing resources/planning/implementing programs arid lands agriculture, shall review published information and data, and make on-the-ground observations to gather information on soil and water resources, availability of production inputs and credit, market potentials, present crop and livestock production, and particular hazards and bottle-necks to production.

3. A Civil Engineer (soil and water conservation with extensive experience in technology for water conservation/use, including water spreading, surface inpondments, small irrigation systems, etc., shall review existing information on water resources (surface and ground), irrigation perimeters (large and small), water resources available for

development, small dams and reservoirs and possibilities for constructing additional ones, soil erosion and water runoff, and present use of water conservation measures on crop and rangeland.

4. Rural Sociologist - (a) to review all pertinent data on target groups and perform necessary on-site preliminary interviews; (b) identify and assess problems associated with the introduction and obtaining acceptance of new and/or different agricultural packages or delivery systems/services, including examination of the socio-economic characteristic of the beneficiaries of sub-systems/sources.

IV. REPORTING REQUIREMENTS

A. Prior to departure from Tunis the Contractor shall submit a draft report to and discuss its findings, appraisal and recommendations with USAID/Tunisia. A draft copy of said report shall be submitted to the Mission Director prior to departure from Tunisia.

B. Within thirty (30) days after the team returns to the U.S. a final report (in twenty copies) shall be submitted including the following:

1. An appraisal of the agricultural potential of the program area;

2. Alternative strategies, research and technical assistance requirements for agricultural development showing linkages between GOT and International Research Centers for proposed program area over the next several years;

3. Relative feasibility and priority of specific agricultural development activities.

C. Distribution of the final report shall be made as follows:

1. Ten (10) copies in English shall be forwarded to the Contracting Officer, AID/Washington.

2. Ten (10) copies in English shall be forwarded to:

Mr. Hermon Davis, Director
USAID/Tunis
Agency for International Development
Washington, D.C. 20523

French translations of the report are to be agreed upon by team leader and Mission Director prior to teams departure.

V. PLACE OF WORK ORDER PERFORMANCE

In order to obtain the necessary information, the Contractor along with other U.S. team members will conduct research and consult with appropriate officials of AID/W, USAID/Tunisia and the Government of Tunisia.

The team is authorized to make one round trip to AID/W if required for final report preparation.

VI. TERM OF WORK ORDER PERFORMANCE

A. Services to be provided hereunder shall be performed during the period February 22, 1978 through June 10, 1978 unless otherwise extended in writing by the Contracting Officer.

APPENDIX SECTION F

Illustrations of Area Problems and Proposed Interventions

Diversion of runoff from temporary stream channels that only carry water during and immediately after rainfall events is technically feasible. The amount of human effort needed is very large during the wet period and also for sediment removal and repair work between rains. The channel in the lower picture (Foussana) is no longer in use due to sedimentation. The channel in the upper left photo (Kasserine) is no longer used due to berm failures in several locations.

Even small impoundments must be constructed with proper material selection and compaction control. This structure on Forest Department land along the access road to Djebel Chambi can be expected to fail before the stored water depth reaches design maximum depth. Note the zones of slippage in the upper photo.

Oued Charchara, left and right above, and Oued Riah, below, are two examples of potential sites for large dam sites in Foussana delegation. Similar sites exist in all delegations visited. Investment costs would be very high. Cost benefit ratio would be very low unless an inordinate value were placed on ground water recharge. Number of families directly served with a sure water supply would be very low. Recharge to ground water would be a positive benefit but is a very difficult to forecast with precision.

There is little apparent difference in vegetation in the two pictures above. Both are badly overgrazed. The pasture on the left has four to six times the annual meat production due *only* to delayed rotational grazing. The best (left) situation can be improved dramatically by reintroducing perennials.

Cacti seem to have a place as emergency survival ration for livestock in driest years. Sale of fruits in wet years helps justify the investment.

Human and animal water needs demand a very large share of the available human energy where water is severely limiting. Clockwise from lower right: children and donkey delivering family water barrel; open cistern accepting grazing area runoff; covered cistern accepting roadside runoff and AID demonstration 100 cubic meter cistern with 1000 square meter paved "watershed."

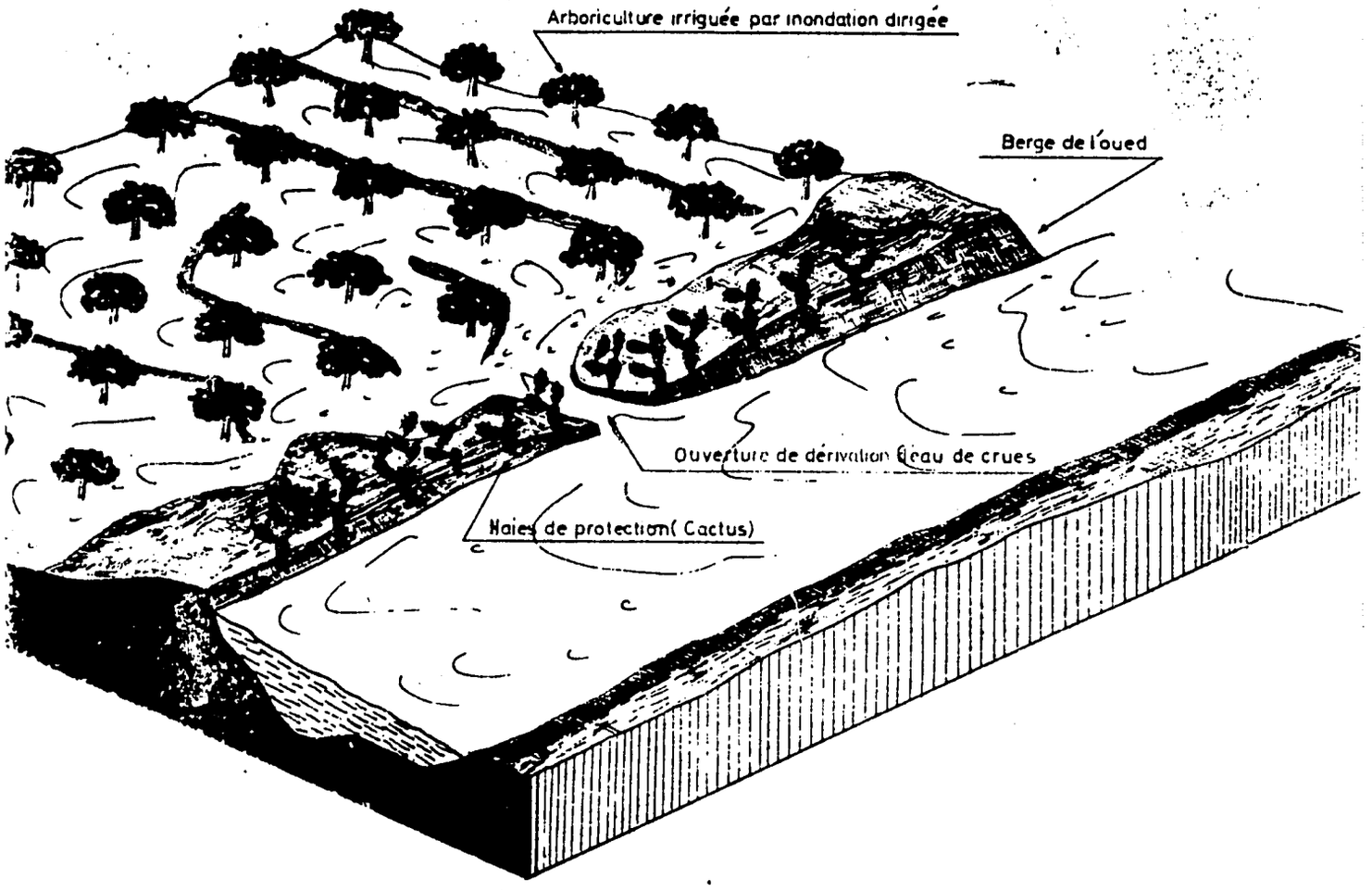
The field behind the Land Rover has a long uniform slope for more than a kilometer. It is annually cropped to cereals. There are no terraces. The head of this gully is advancing several feet each year and will continue to advance until the slope above has a complete set of terraces designed to prevent overpour of runoff water into the head of the gully.

Very small water impoundments are only useful in the wet season of the wet years. They do not control erosion on the sloping land above and soon lose their effectiveness through siltation and "wash outs." Pictures from Jedliane delegation in March 1978.

OCCASIONAL IRRIGATION THROUGH CONTROLLED FLOODING

Spreading of Channel Runoff Following Rainfall

CENTRAL TUNISIA



_ Schéma Nº_3_

Source: C.R.G.R., Tunisia.

PERMANENT IRRIGATION THROUGH CONTINUOUS STREAM DIVERSION

CENTRAL TUNISIA

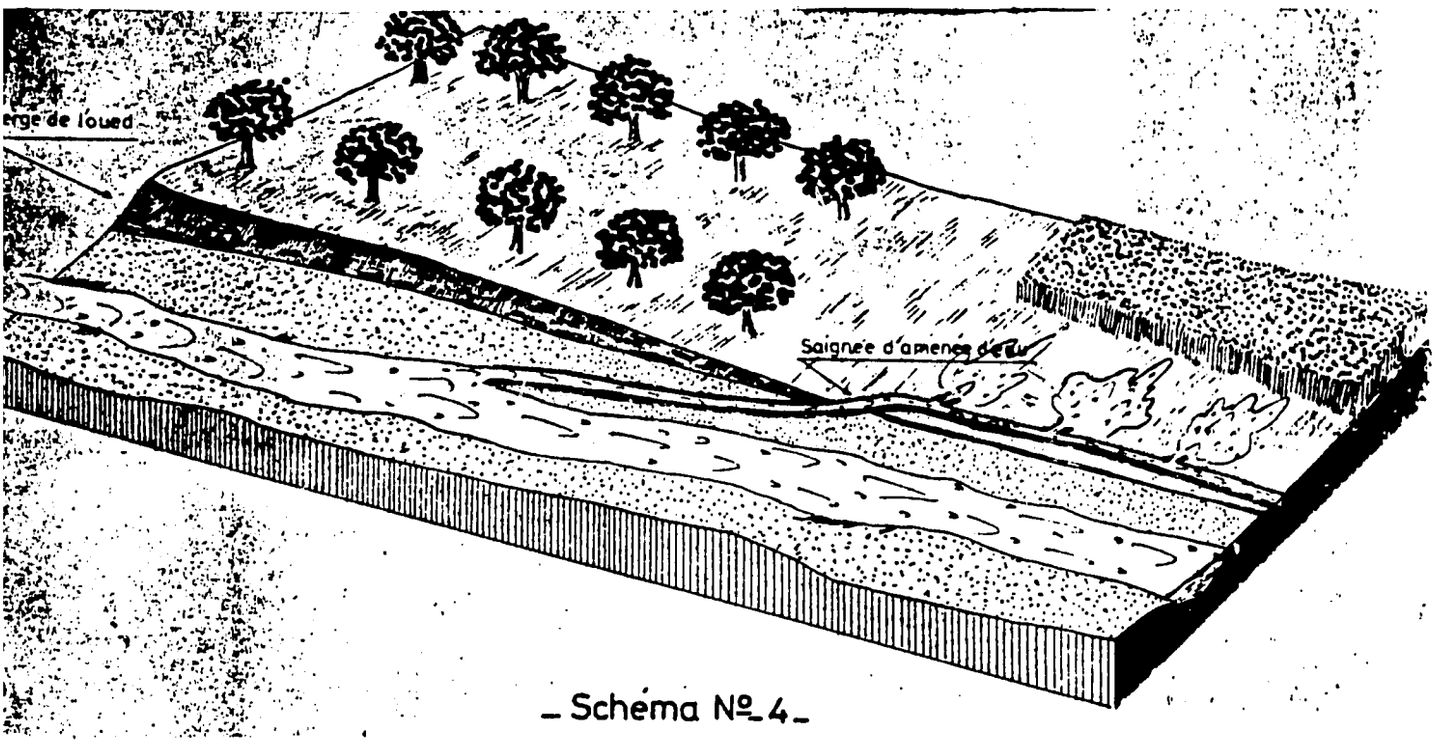
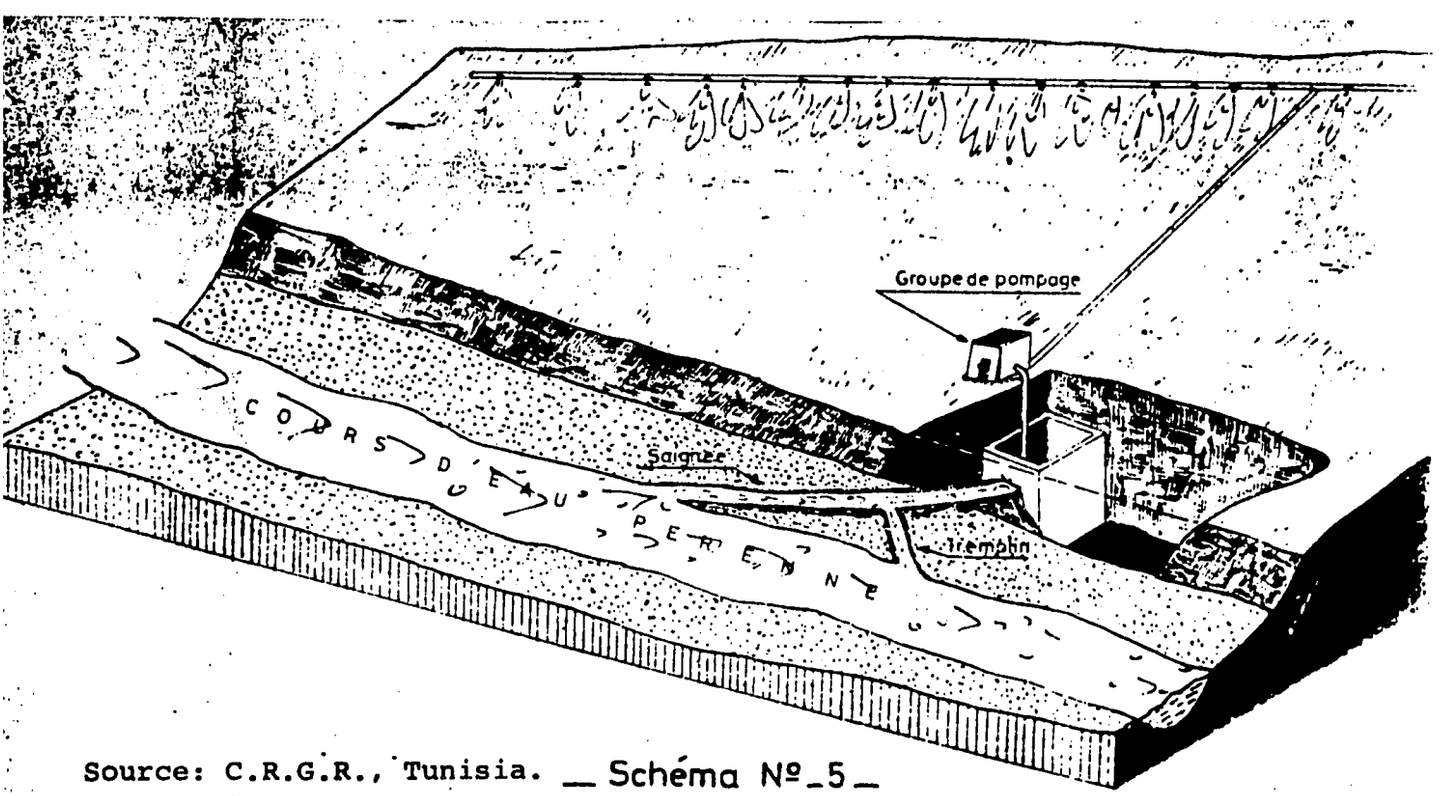


_Schéma Nº_4_

PERMANENT IRRIGATION BY PUMPING FROM STREAMBANK WELL



Source: C.R.G.R., Tunisia. _ Schéma Nº_5_